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INSECTS AND FUNGI ASSOCIATED WITH CARDUUS THISTLES (COMPOSITAE)

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ABSTRACT

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Six Eurasian species of *Carduus* thistles (Compositae: Cynareae) are troublesome weeds in North America. They are attacked by about 340 species of phytophagous insects, including 71 that are oligophagous on Cynareae. Of these Eurasian insects, 39 were extensively tested for host specificity, and 5 of them were sufficiently damaging and stenophagous to warrant their release as biological control agents in North America. They include four beetles: *Altica carduorum* Guérin-Méneville, repeatedly released but not established; *Ceutorhynchus litura* (F.), established in Canada and Montana on *Cirsium arvense* (L.) Scop.; *Rhinocyllus conicus* (Froelich), widely established in the United States and Canada and beginning to reduce *Carduus nutans* L. populations; *Trichosirocalus horridus* (Panzer), established on *Carduus nutans* in Virginia; and the fly *Urophora stylata* (F.), established on *Cirsium* in Canada.

Potentially useful and probably host-specific fungi attacking *Carduus* include five species of *Puccinia* and two species of *Uredo*.

KEYWORDS: Biological control, *Carduus*, *Cirsium*, phytophagous insects, rust fungi, thistles, weed control, weeds.





A terminal inflorescence of musk thistle (*Carduus nutans*) with its introduced biological control agent, the seed-destroying European weevil (*Rhinocyllus conicus*).

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by

S. W. T. BATRA, J. R. COULSON,
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INSECTS AND FUNGI ASSOCIATED WITH CARDUUS THISTLES (COMPOSITAE)

By S. W. T. BATRA, J. R. COULSON, P. H. DUNN, and P. E. BOLDT¹

ECONOMIC IMPORTANCE, CONTROL, AND BIONOMICS OF CARDUUS THISTLES

The genus *Carduus* (Compositae: Cynareae: Carduinae) includes species in the subgenera *Alfredia* and *Afrocarduus* Kazmi (1963, 1964),² which are not weedy. The Palaearctic subgenus *Carduus* includes 70 species, 59 apparent species hybrids, and 60 subspecies, according to the revision by Kazmi (1964); some species are noxious weeds. An additional species, four apparent hybrids, and one subspecies of Eurasian *Carduus* were included in the "Index Kewensis" in 1974. Although similar to *Cirsium* thistles, *Carduus* species may readily be distinguished from them by their simple, not feathery, pappus hairs and lack of resin streaks on involucral leaves (Kazmi, 1964).

Infestations of some introduced Eurasian species of *Carduus* (plumeless thistles) of actual or potential economic importance occur in 18 percent of the counties in the contiguous United States. Musk or nodding thistles (*C. nutans* and *C. thoermeri*)³ occur as economic infestations in over 10 percent of all counties, primarily in the Midwest, and appear to be spreading (Dunn, 1976). They occupy about 2 million acres in the United States, and chemical control alone cost about \$6.50 per acre in 1976 (M. K. McCarty, pers.

¹S. W. T. Batra and J. R. Coulson, Beneficial Insect Introduction Laboratory, Beltsville Agricultural Research Center, Beltsville, Md. 20705; P. H. Dunn, Biological Control of Weeds Laboratory, Albany, Calif. 94706; and P. E. Boldt, Biological Control of Weeds Laboratory, Rome, Italy.

²The year in italic after an author's name refers to Literature Cited, p. 86.

³For complete scientific names with authority or describer, see index (plants).

commun.). Plumeless thistle (*C. acanthoides*) is a problem in the Appalachian region; Italian thistle (*C. pycnocephalus*) and slender flower thistle (*C. tenuiflorus*) are economically important in California; and curled or welted thistle (*C. crispus*) is common in western Virginia (Johnson, 1974; Dunn, 1976).

These large, spiny, annual or biennial plants are particularly troublesome in pastures, where they crowd out forage plants (fig. 1), and in fallow fields and along railways or roadsides, where mowing or spraying with herbicides may be uneconomical or impractical, allowing *Carduus* thistles to become a seed source for reinfestation of treated areas. They may invade cultivated areas as the use of the no-tillage method of cultivation increases.

The *Carduus* thistles from Eurasia also have become problem weeds where introduced into other continents. *Carduus nutans* and *C. thoermeri* are important weeds in South America and have recently been found in eastern Australia. In New Zealand, *C. nutans* is common (Doing et al., 1969). The slender thistles (*C. pycnocephalus* and *C. tenuiflorus*) are the major weeds in sheep pastures in Tasmania, but they may be effectively controlled by grazing management (Bendall, 1973, 1974). *Carduus pycnocephalus* is an im-



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FIGURE 1.—Dairy cattle in a typical overgrazed pasture infested by *Carduus nutans* in Pennsylvania. Not only are the thistles not eaten, but the cattle do not reach for the edible plants growing near them.

portant introduced weed in South Africa (Henderson and Anderson, 1966); *C. nutans* also occurs there, where it is used for making bows (Kazmi, 1964). In Canada, *C. crispus*, $2N=16$, *C. nutans* (ssp. *nutans*, *leiophyllus*, *macrolepis*), and *C. acanthoides* are present, as well as the hybrid *C. × orthocephalus*, $2N=17=21$ (= *nutans*, $2N=16$; *acanthoides*, $2N=22$) (Mulligan and Frankton, 1954; Moore and Frankton, 1974). These hybrids, resembling *C. acanthoides*, have become numerous and appear to have been ecologically and gametically selected for local survival in rocky pastures in Grey County, Ontario (Moore and Mulligan, 1956, 1959; Mulligan and Moore, 1961). In Nebraska, "musk" thistles are *C. thoermeri* (M. K. McCarty, pers. commun., 1978), not hybrids of *C. nutans* and *C. acanthoides* (Fuller, 1969). The identification and descriptions of these thistles are discussed by Kazmi (1964), Mulligan (1965), Furrer and McCarty (1966), Wunderlin (1969), McCarty et al. (1973), Johnson (1974), and Moore and Frankton (1974).

The readiness with which *Carduus* species apparently interbreed could lead to the development of some hybrids that are even more adaptable and aggressive weeds than their parents because of the enrichment of variation through introgressive hybridization. This and related problems in other weeds are discussed by Baker (1965). However, hybridization may also provide an opportunity for control by introducing clones relatively susceptible to natural enemies or herbicides.

In addition to the known hybrid *C. × orthocephalus* mentioned previously, possible European hybrids of the weedy species already present in the United States and Canada are as follows according to morphological studies of Kazmi (1964):

<i>Species in North America</i>	<i>European 'hybrids'</i>
<i>C. acanthoides</i> × <i>C. crispus</i> ($2N=16$)	= <i>C. × leptocephalus</i>
<i>C. acanthoides</i> × <i>C. pycnocephalus</i> ($2N=54$)	= not named, morphologically resembles <i>C. acanthoides</i>
<i>C. crispus</i> × <i>C. nutans</i>	= <i>C. × dubius</i>
<i>C. crispus</i> × <i>C. tenuiflorus</i> ($2N=54$)	= <i>C. × crispo-tenuiflorus</i>
<i>C. crispus</i> × <i>C. thoermeri</i> ($2N=16$)	= <i>C. × semiperegrinus</i>
<i>C. nutans</i> × <i>C. pycnocephalus</i>	= <i>C. × pernuntanti-pycnocephalus</i>
<i>C. nutans</i> × <i>C. tenuiflorus</i>	= <i>C. × mixtus</i>
<i>C. pycnocephalus</i> × <i>C. tenuiflorus</i>	= <i>C. × theriottii</i>

More cytogenetic and ecological studies of possible *Carduus* hybrids are much needed.

Because of its economic importance, considerable basic research has been undertaken on the bionomics and control of the musk thistle in North America (see Feldman et al. (1968), McCarty et al.

(1969), McCarty and Scifres (1969), and McCarty and Hatting (1975)). It was evidently introduced at ballast dumps on the east coast (Dunn, 1976) and in Alabama between about 1850 and 1900 (specimens at U.S. Natl. Mus.), and it was considered a weed in the mid-Atlantic States by the early 1900's (Furrer and McCarty, 1966). It rapidly spread, becoming economically important in the Midwest by 1950 (Furrer and McCarty, 1966).

This adaptable plant is now abundant in North Dakota, Louisiana, and on both coasts, but the most serious infestations are in the Central States (Dunn, 1976). In Nebraska, it is found primarily in rich, moist lowland, although it will occupy poor soils (McCarty, 1964; McCarty et al., 1973), and in Ontario, it occurs on well-drained loam or stony pastures (Mulligan and Moore, 1961). In western Virginia, it is common in the Appalachian region, but it is scarce in the Piedmont or coastal plain (Johnson, 1974). In Maryland and south-central Pennsylvania, musk thistle is locally abundant with *C. acanthoides* in pastures and on roadsides in the Appalachian Great Valley. Seeds may have been initially spread by wind, vehicles, and in soil from infested quarries. According to Hensley (1973), *C. nutans* and *C. acanthoides* are most plentiful in limestone soils in Virginia. In Ohio, *C. nutans* is most common where limestone or dolomite bedrock is less than 6 feet below the surface (Stuckey and Forsyth, 1971).

In its native Europe, musk thistle is a ruderal pioneer in disturbed environments on calcareous, loamy, or sandy soil rich in nitrogen; however, it may become a problem in overgrazed pastures. According to Doing et al. (1969), the most significant characters restricting its distribution are low tolerance for lack or excess of moisture and of deficient or acid soils and an only moderately high competitive power.

Musk thistles may be controlled by grazing management in maintaining a dense mat of perennial grasses, but the release of grazing pressure on annual grassland has resulted in an increase of these thistles in Australia (Doing et al., 1969). However, in Nebraska, Feldman et al. (1968) found that musk thistles did not become established in ungrazed pastures; survival was highest in intensively grazed pastures. This thistle may behave as a short-lived perennial, producing new shoots when grazed or sprayed in the spring (Doing et al., 1969), and may thus increase difficulty of control. Treatment with the herbicides dicamba (3,6-dichloro-o-anisic acid) plus 2,4-D (Jensen, 1970; McCarty and Hatting, 1975) or picloram (4-amino-3,5,6-trichloropicolinic acid) (Feldman et al., 1968; Jensen, 1970) was fairly effective. Control for 2 years cost from \$6.25 to \$14.75 per acre (Jensen, 1970). Mowing musk thistles

within 2 days of the first terminal heads in a population showing anthesis eliminated production of viable seed from all mowed stalks, but repeated mowing is necessary owing to differences in plant maturity (McCarty and Hatting, 1975).

Carduus thistles have been little used by people. The young stalks are edible and the pappus has been used for papermaking (Moore and Frankton, 1974). They are not considered important to vertebrate wildlife in North America (Martin et al., 1961). Seeds of *C. nigrescens* are a rich source of pentacyclic triterpenes (Madrigal et al., 1974); *C. albida* was tested but found lacking in ecdysones (Ganiev, 1975). The fragrant, beautiful flowers of *C. acanthoides* (white and purple varieties) and *C. nutans* are occasionally visited by insects (Mulligan and Kevan, 1973). At Beltsville, Md., bumble bees and halictine bees are important pollinators of these plants. According to Crane (1975), honey bees working *Carduus* and *Cirsium* thistles provide a light, sweet honey of good flavor; *Carduus hamulosus* gives a moderate honey yield (26-50 kg per hectare). The elaiosome-bearing seeds of the myrmecophile *C. pycnocephalus* are transported by ants (Uphof, 1942).

BIOLOGICAL CONTROL OF CARDUUS THISTLES

Because of the expense of controlling *Carduus* thistles by mowing or applying herbicides in areas where they are prevalent, such as pastures, fallow fields, wasteland, quarries, roadsides, or railways, biological control by arthropods or pathogens is a reasonable alternative or adjunct. It has the advantage of being relatively inexpensive and harmless to nontarget organisms, and biological control agents can multiply and spread to adjacent infested areas. The principles and procedures of biological control have been well defined and tested with some spectacular successes (see Huffaker (1956), Wilson (1964), Harris and Zwölfer (1968), Andres (1971), Harris (1971), Zwölfer and Harris (1971), Harris (1973a, b), Wapsphere (1974), Andres and Bennett (1975), and Goeden and Louda (1976)).

Carduus thistles are prime candidates for biological control because (1) it is often impractical or too expensive to mechanically destroy or spray them; (2) they have been introduced from another continent, leaving behind their natural enemies; (3) they are usually biennial; (4) they build up dense populations, maintained for several years; (5) they are not closely related to major crop plants except artichoke, sunflower, and safflower; and (6) they have little value to people or wildlife.

Biological control increases environmental pressure on *Carduus* thistles. At best, the natural enemies may eliminate the need for

other control methods over much of the plant's range and form a sound basis for future weed-management schemes. At least these natural enemies would augment existing control practices. A comprehensive list of the natural enemies of *Carduus* species is a needed step in the process of selecting promising candidates.

Biological control of *Carduus* thistles in North America began with the introduction of the weevil *Rhinocyllus conicus* (Froelich), which was first released in Canada in 1968 after 6 years of study and testing in Europe and North America by scientists of the Commonwealth Institute of Biological Control, the Canada Department of Agriculture, and the former Agricultural Research Service (now a part of the Science and Education Administration (SEA-AR)). It is beginning to provide a significant degree of control of *C. nutans* in Virginia (Kok and Surles, 1975) and in Montana (Hodgson and Rees, 1976). *Rhinocyllus conicus* has also been established in California to control milk thistle (*Silybum marianum* (L.) Gaertn.) (Hawkes et al., 1972) and in New Zealand to control *C. nutans* (Jessep, 1975).

Assistance in locating sources of approved agents for biological control of *Carduus* thistles can be provided by the U.S. Department of Agriculture's Beneficial Insect Introduction Laboratory, Building 417, Beltsville Agricultural Research Center-East, Beltsville, Md. 20705; USDA Biological Control of Weeds Laboratory, 1050 San Pablo Avenue, Albany, Calif. 94706; and Agriculture Canada Research Station, Box 440, Regina, Saskatchewan S4P 3A2.

PHYTOPHAGOUS INSECTS ASSOCIATED WITH CARDUUS THISTLES

The first step in any project for the biological control of weeds is to prepare a list of natural enemies associated with the target plant. A list has been compiled here to give interested workers available information on the biological control of weeds. It incorporates data extracted from publications, as well as from reports, letters, and other unpublished material located in the files of the Insect Identification and Beneficial Insect Introduction Institute (IIBIII), SEA, USDA, Beltsville, Md., with few exceptions, as of December 31, 1976.⁴ Records from museum specimens have not been included, and the taxonomic literature is not exhaustively cited because this is not intended as a bibliography. Data on *Carduus* thistle in-

⁴Although most data on which this publication is based were collected prior to 1977, the information is still valid and useful as guidelines for those interested in the biological control of weeds.

sects not in the Beneficial Insect Introduction Laboratory (BIIL) files are not summarized here. The compilers do not claim to have been able to detect or correct all possible inaccuracies in the sources available.

This list is to serve only as a source of information to aid in further studies and to make known some of the insects discovered on *Carduus* and what studies have been or are being conducted. It is not intended to serve as a final authority for determining host plants, geographical ranges, and so forth. Detailed information on any of the insects or laboratory tests should be obtained from those laboratories from whose reports or publications the pertinent data have been extracted. An unpublished preliminary version of this list, circulated by J. R. Coulson in 1969, has been cited, e.g., in Goeden (1974, 1976). An index to the *Carduus* species mentioned in the list and their associated insects and fungi is included.

Names of insects.—The names of insects have been checked by specialists of the Systematic Entomology Laboratory, SEA-AR.

Plant records.—All species of *Carduus* (as recognized by Kazmi (1964) and in litt. (1977)) are listed here with the particular insects with which they have been associated or recorded. This association may not always indicate a specific host plant relationship, but it may sometimes be simply a record of the insect casually feeding on the species in the field or in a laboratory test. In the field records, the location usually follows the plant species in parentheses. Explanations of these records are to be found under Remarks. These comments refer also to the records on plant genera other than *Carduus*. However, in these instances, only the generic name of the plant is given, and the record may refer to one or more species of that genus.

Remarks.—This section is a brief summary of available information on the insect from laboratory and field studies.

Sources.—The sources of unpublished information are referred to by the names of the stations reporting the information and the years of the reports. When data are from many sources, each item is not specifically attributed to a definite source. If such information on a specific source is desired, it can be supplied by the authors.

The laboratories that have kindly allowed the use of information from their unpublished reports for this list include the Commonwealth Institute of Biological Control stations of Delémont, Switzerland, and Rawalpindi, Pakistan; the SEA-AR Biological Control of Weeds laboratories at Rome, Italy, and Albany, Calif.; the BIIL, Beltsville, Md.; the Biological Control of Weeds Research Group of Agriculture Canada at Regina, Saskatchewan (formerly at Belleville, Ontario); and the Department of Entomology, Virginia

Polytechnic Institute and State University, Blacksburg. Data from reports of several P.L. 480 projects on biological control of weeds supported by SEA-AR are also included in this list; e.g., projects at Rawalpindi, Pakistan (A17-ENT-9 and A17-ENT-14 terminated in 1965 and 1970, respectively) and at the Ministry of Agriculture, Dokki, Egypt (F4-ENT-5 and F4-ENT-16, completed in 1970 and 1974). Much of the data included in these unpublished reports has since been published, e.g., in Zwölfer (1965a, b) and Baloch et al. (1971), and efforts have been made here to refer to the published source. However, some other records from the unpublished reports have also been included in this list for completeness.

Abbreviations used here are as follows:

General Abbreviations

A – Adults

Addit. – Additional

Agr. – Agriculture

Ann. – Annual

ARS – Agricultural Research
Service (now SEA-AR)

Centr. – Central

CIBC – Commonwealth Institute of Biological
Control

Coll. – Collected

Dept. – Department

Distrib. – Distribution

E. – East, eastern

Et al. – and others

Ft. – Fort

Ident. – Identified, identification

Incl. – Includes, including

In litt. – In correspondence

Inst. – Institute

Is. – Island

Km – Kilometers

L – Larvae

Lab. – Laboratory

Locs. – Locations, localities

Misident. – Misidentified, misidentification

Mts. – Mountains

N. – North, northern

Nat. – National

No(s). – Number(s)

Nr. – Near

Pers. comm. – Personal communication
Poss. – Possibly
Prob. – Probably
Rec(s). – Record(s), recorded
Res. – Research
Rpt(s). – Report(s)
S. – South, southern
SEA-AR – Science and Education
 Administration-Agricultural
 Research
Sp(p). – Species
Spec. – Special
Ssp. – Subspecies
SW. – Southwest, southwestern
Unident. – Unidentified
USDA – United States Department of
 Agriculture
Var. – Variety
VPI – Virginia Polytechnic Institute and State
 University
Vs. – Versus
W. – West, western
Yr(s). – Year(s)

Locality Abbreviations

Countries

U.S. – United States
USA – United States of America
USSR – Union of Soviet Socialist Republics

Canadian Provinces

Alta. – Alberta
B.C. – British Columbia
Man. – Manitoba
N.B. – New Brunswick
N.S. – Nova Scotia
Ont. – Ontario
Que. – Quebec
Sask. – Saskatchewan

United States

Amer. – America	Colo. – Colorado
Calif. – California	Del. – Delaware

United States—Continued

Ind. — Indiana	N.J. — New Jersey
Kans. — Kansas	N.Y. — New York
Ky. — Kentucky	Oklahoma — Oklahoma
La. — Louisiana	Oreg. — Oregon
Md. — Maryland	Pa. — Pennsylvania
Mich. — Michigan	S. Dak. — South Dakota
Minn. — Minnesota	Tenn. — Tennessee
Mo. — Missouri	Va. — Virginia
Mont. — Montana	W. Va. — West Virginia
N. Dak. — North Dakota	Wash. — Washington
Nebr. — Nebraska	Wis. — Wisconsin
Nev. — Nevada	Wyo. — Wyoming

LIST OF INSECTS**COLLEMBOLA***Sminthuridae*

Unident. sminthurid sp.

Plant recs.: *Carduus pycnocephalus* (S. Europe)

Remarks: Occasional adults feeding on leaves

Sources: Goeden (1974)

THYSANOPTERA

Unident. thrips sp.

Plant recs.: *Carduus defloratus* (Switzerland); *C. nutans* (S. Dak.)

Remarks: In flowers

Sources: Delémont Rpt. (1963); Morihara and Balsbaugh (1976)

*Phlaeothripidae**Haplothrips distinguendus* (Uzel)Plant recs.: *Carduus pycnocephalus* (S. Europe)

Remarks: Locally common; adults on flowers; polyphagous

Sources: Goeden (1974)

*Thripidae**Anaphothrips (Apterothrips) secticornis* (Trybom)Plant recs.: *Carduus pycnocephalus* (S. Calif.)

Remarks: Rare; adults feeding on rosette leaves; polyphagous

Sources: Goeden (1974)

Frankliniella occidentalis (Pergande)Plant recs.: *Carduus pycnocephalus* (S. Calif.)Remarks: Rare; adults ectophagous on flowers;
polyphagous

Sources: Goeden (1974)

DERMAPTERA

Forficulidae

Forficula auricularia L.Plant recs.: *Carduus pycnocephalus* (S. Europe)Remarks: Rare; nymphs and adults on leaves and stems;
polyphagous

Sources: Goeden (1974)

ORTHOPTERA

Gryllidae

Unident. gryllid sp.

Plant recs.: *Carduus pycnocephalus* (S. Calif.); *C. nutans* (S. Dak.)

Remarks: Rare; nymphs feeding on leaves of rosette

Sources: Goeden (1974); Morihara and Balsbaugh (1976)

Oecanthus nigricornis SaussurePlant recs.: *Carduus nutans* (S. Dak.)

Remarks: Nymphs and adults ectophagous

Sources: Morihara and Balsbaugh (1976)

Tettigoniidae

Unident. tettigoniid spp. (3)

Plant recs.: *Carduus pycnocephalus* (S. Calif.); *C. nutans* (S. Dak.)

Remarks: Nymphs and adults ectophagous

Sources: Goeden (1974); Morihara and Balsbaugh (1976)

Acrididae

Unident. acridid spp. (2)

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Nymphs and adults ectophagous on leaves

Sources: Morihara and Balsbaugh (1976)

Melanoplus sp.Plant recs.: *Carduus nutans* (S. Dak.)Remarks: Nymphs and adults ectophagous on leaves;
polyphagous crop pest

Sources: Morihara and Balsbaugh (1976)

ORTHOPTERA—Continued

Acrididae—Continued

Melanoplus bivittatus (Say)Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Abundant; nymphs and adults ectophagous on leaves; polyphagous crop pest

Sources: Morihara and Balsbaugh (1976)

Melanoplus differentialis (Thomas)Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Abundant; adults ectophagous on leaves; polyphagous crop pest

Sources: Morihara and Balsbaugh (1976)

Melanoplus femur-rubrum (De Geer)Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Abundant; nymphs and adults ectophagous on leaves; polyphagous crop pest

Sources: Morihara and Balsbaugh (1976)

HEMIPTERA-HETEROPTERA

Miridae

Unident. mirid spp.

Plant recs.: *Carduus pycnocephalus* (S. Europe); *C. nutans* (S. Dak.)

Remarks: Nymphs and adults on foliage

Sources: Goeden (1974); Morihara and Balsbaugh (1976)

Adelphocoris lineolatus (Goeze)Plant recs.: *Carduus crispus* (Europe); *C. nutans* (S. Dak.); *Cirsium*Remarks: Occasional visitor on *Carduus*; polyphagous crop pest

Sources: Zwölfer (1965a); Morihara and Balsbaugh (1976)

Calocoris norvegicus (Gmelin)Plant recs.: *Carduus crispus* (Europe); *C. pycnocephalus* (S. Europe); *Cirsium*Remarks: Nymphs and adults from foliage of *Carduus*; polyphagous

Sources: Zwölfer (1965a); Goeden (1974)

Chlamydatus associatus (Uhler)Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Adults; ectophagous on Compositae

Sources: Morihara and Balsbaugh (1976)

Irbisia sp. nr. *I. californica* Van DuzeePlant recs.: *Carduus pycnocephalus* (S. Calif.)

Remarks: Locally common; nymphs and adults ectophagous on flowers, leaves, and stems; polyphagous

Sources: Goeden (1974)

Lopidea sp.

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Adults; uncommon

Sources: Morihara and Balsbaugh (1976)

Lygus hesperus (Knight)

Plant recs.: *Carduus pycnocephalus* (S. Calif.)

Remarks: Occasional nymphs and adults ectophagous on flowers; polyphagous crop pest

Sources: Goeden (1974)

Lygus lineolaris (Palisot de Beauvois)

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Adults ectophagous on stems and flowers; polyphagous crop pest

Sources: Morihara and Balsbaugh (1976)

Lygus pratensis (L.)

Plant recs.: *Carduus nutans* (Europe); *Cirsium*

Remarks: Occasional visitor on *Carduus*; polyphagous

Sources: Zwölfer (1965a)

Plagiognathus sp. nr. *P. confusus* Reuter

Plant recs.: *Carduus pycnocephalus* (S. Calif.)

Remarks: Adults on flowers

Sources: Goeden (1974)

Plagiognathus arbustorum (F.)

Plant recs.: *Carduus nutans* (Europe); *Cirsium*

Remarks: Occasional visitor on *Carduus*

Sources: Zwölfer (1965a)

Plagiognathus obscurus Uhler

Plant recs.: *Carduus* sp. (Va.); *Cirsium* (Canada)

Remarks: Frequent feeder; polyphagous

Sources: L. T. Kok in litt. (1976); Maw (1976)

Plagiognathus politus Uhler

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Eggs, nymphs; ectophagous on Compositae

Sources: Morihara and Balsbaugh (1976)

Poecilocapsus lineatus (F.)

Plant recs.: *Carduus* sp. (Va.); *C. nutans* (S. Dak.); *Cirsium* (Canada)

Remarks: Nymphs and adults frequent feeders; polyphagous pest

Sources: L. T. Kok in litt. (1976); Morihara and Balsbaugh (1976); Maw (1976)

HEMIPTERA-HETEROPTERA—Continued

Miridae—Continued

Semium hirtum ReuterPlant recs.: *Carduus nutans* (S. Dak.)

Remarks: Uncommon; adults ectophagous; polyphagous

Sources: Morihara and Balsbaugh (1976)

Tingidae

Tingis cardui (L.)Plant recs.: *Carduus defloratus* (Switzerland); *C. crispus* (Rhine Valley); *C. acanthoides* (Jura, W. France); *C. pycnocephalus*, *C. acanthoides* (Europe); *Cirsium*, *Galactites* (Europe)Remarks: Adults and nymphs found externally on leaves and stems; literature restricts hosts to *Carduus-Cirsium*

Sources: Delémont Rpts. (1962–63); Zwölfer (1965a); Eguagie (1974)

Lygaeidae

Unident. lygaeid spp.

Plant recs.: *Carduus pycnocephalus* (S. Europe); *C. nutans* (S. Dak.)

Remarks: Rare; adults ectophagous on leaves; polyphagous

Sources: Goeden (1974); Morihara and Balsbaugh (1976)

Geocoris uliginosus (Say)Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Rare; adults ectophagous on flowers; on other Compositae

Sources: Morihara and Balsbaugh (1976)

Lygaeus equestris (L.)Plant recs.: *Carduus nutans* (Europe); *C. pycnocephalus* (S. Europe)

Remarks: Occasional visitor on flowers and leaves; polyphagous

Sources: Zwölfer (1965a); Goeden (1974)

Melanocoryphus bicrucis (Say)Plant recs.: *Carduus pycnocephalus* (S. Calif.)

Remarks: Rare; adults ectophagous on flowers and stems; polyphagous

Sources: Goeden (1974)

Coreidae

Ortholomus sp.Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Rare; adults ectophagous

Sources: Morihara and Balsbaugh (1976)

Syromastes marginatus (L.) (= *Coreus marginatus*)

Plant recs.: *Carduus nutans* (Europe); *Cirsium*

Remarks: Occasional visitor

Sources: Zwölfer (1965a)

Pentatomidae

Aelia sp.

Plant recs.: *Carduus crispus* (Europe)

Remarks: Occasional visitor

Sources: Zwölfer (1965a)

Carpocoris pudicus (Poda)

Plant recs.: *Carduus nutans* (Europe); *Cirsium*, *Silybum*, *Centaurea*

Remarks: Nymphs and adults found on stem and leaves

Sources: Zwölfer (1965a)

Carpocoris purpureipennis De Geer (and/or var. *pallidus* Distant)

Plant recs.: *Carduus edelbergii* (Pakistan); many other hosts

Remarks: Polyphagous; "a known pest"; exophytic on stems and leaves

Sources: A17-ENT-9 Rpt. (1965); Baloch et al. (1971)

Chlorochroa uhleri Stål

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Rare; adults; polyphagous

Sources: Morihara and Balsbaugh (1976)

Cosmopepla bimaculata (Thomas)

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Nymphs, adults on flowers and leaves; polyphagous

Sources: Morihara and Balsbaugh (1976)

Dolycoris baccarum (L.)

Plant recs.: *Carduus nutans* (Europe); *Cirsium*, *Onopordum*, *Centaurea*, *Echinops*

Remarks: Nymphs and adults found on stems and leaves; polyphagous; attacks crops

Sources: Zwölfer (1965a)

Dolycoris indicus Stål

Plant recs.: *Carduus edelbergii* (Pakistan); *Carthamus*, *Xanthium*, *Calotropis*, *Cannabis*, *Cnicus*, *Salvia*, *Ziziphus*

Remarks: Adults suck sap of *Carduus* and *Xanthium*; polyphagous crop pest

Sources: A17-ENT-9 Rpts. (1961, 1965); Baloch et al. (1968, 1971)

HEMIPTERA-HETEROPTERA—Continued

Pentatomidae—Continued

Eurydema lituriferum WalkerPlant recs.: *Carduus edelbergii* (Pakistan)Remarks: Adults suck sap from leaves of *Carduus*

Sources: A17-ENT-9 Rpt. (1965); Baloch et al. (1971)

Eurydema oleraceum (L.)Plant recs.: *Carduus nutans* (Europe); *Cirsium*Remarks: Occasional visitor on *Carduus*

Sources: Zwölfer (1965a)

Eurydema ornatum (L.) (= *E. festivum* L.)Plant recs.: *Carduus edelbergii* (Pakistan)

Remarks: Exophytic on stems and leaves; polyphagous; attacks many crops

Sources: A17-ENT-9 Rpts. (1961, 1965); Baloch et al. (1971)

Euschistus conspersus UhlerPlant recs.: *Carduus pycnocephalus* (S. Calif.)Remarks: Rare; adults ectophagous on flowers and leaves; polyphagous; pest of *Cynara*

Sources: Goeden (1974)

Euschistus euschistoidea (Vollenhoven)Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Common; nymphs and adults ectophagous on flowers and leaves; polyphagous

Sources: Morihara and Balsbaugh (1976)

Euschistus tristigmus (Say)Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Nymphs and adults ectophagous on flowers and leaves; attacks other Compositae

Sources: Morihara and Balsbaugh (1976)

Evacanthus ?repexus DistantPlant recs.: *Carduus edelbergii* (Pakistan); many other hosts

Remarks: Polyphagous crop pest

Sources: Baloch et al. (1971)

Nezara viridula (L.)Plant recs.: *Carduus edelbergii* (Pakistan); *C. pycnocephalus* (S. Europe); *C. nutans* (Va.); *Xanthium*, *Cannabis*, *Salvia*Remarks: Adults feeding (sucking sap) on leaves and flowers of *Carduus*; polyphagous crop pest

Sources: A17-ENT-9 Rpts. (1961, 1965); Baloch et al. (1968, 1971); Goeden (1974); L. T. Kok in litt. (1976)

Odontotarsus purpureolineatus (Rossi)Plant recs.: *Carduus nutans* (Europe)

Remarks: Occasional visitor

Sources: Zwölfer (1965a)

Thyanta pallidovirens pallidovirens (Stål)Plant recs.: *Carduus pycnocephalus* (S. Calif.)

Remarks: Rare; adults on stems; polyphagous

Sources: Goeden (1974)

Piesmatidae

Piesma cinera (Say)Plant recs.: *Carduus nutans* (S. Dak.)Remarks: Rare; adults on flowers and leaves;
polyphagous

Sources: Mori hara and Balsbaugh (1976)

Pyrrhocoridae

Pyrrhocoris apterus L.Plant recs.: *Carduus acanthoides* (S. Europe)

Remarks: Rare; adults on leaves; polyphagous

Sources: Goeden (1974)

Rhopalidae

Leptocoris sp. nr. *L. rubrolineatus* BarberPlant recs.: *Carduus pycnocephalus* (S. Calif.)Remarks: Rare; adults ectophagous on flowers and
leaves; polyphagous crop pest

Sources: Goeden (1974)

Leptocoris trivittatus (Say)Plant recs.: *Carduus nutans* (S. Dak.)Remarks: Nymphs, adults ectophagous on leaves, stems,
and flowers; polyphagous crop pest

Sources: Mori hara and Balsbaugh (1976)

Liorhyssus hyalinus (F.)Plant recs.: *Carduus pycnocephalus* (S. Calif.)Remarks: Rare; nymphs ectophagous on shoots;
polyphagous

Sources: Goeden (1974)

Scutelleridae

Unident. scutellerid sp.

Plant recs.: *Carduus pycnocephalus* (S. Europe)

Remarks: Rare; adults eat leaves

Sources: Goeden (1974)

Eurygaster amerinda amerinda BlivenPlant recs.: *Carduus pycnocephalus* (S. Calif.)Remarks: Rare; adults ectophagous on leaves;
polyphagous

Sources: Goeden (1974)

HEMIPTERA-HOMOPTERA

Cicadellidae

Aceratagallia sp.Plant recs.: *Carduus pycnocephalus* (S. Calif.)

Remarks: Occasional adults ectophagous on stems, leaves, and flowers

Sources: Goeden (1974)

Aceratagallia uhleri (Van Duzee)Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Adults; ectophagous

Sources: Morihara and Balsbaugh (1976)

Agallia quadripunctata (Provancher)Plant recs.: *Carduus nutans* (S. Dak.); *Cirsium* (Canada)

Remarks: Rare; adults only; polyphagous

Sources: Morihara and Balsbaugh (1976); Maw (1976)

Agalliopsis novella SayPlant recs.: *Carduus nutans* (S. Dak.)

Remarks: Adults; ectophagous; polyphagous

Sources: Morihara and Balsbaugh (1976)

Deltococephalus signatifrons (Van Duzee)Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Adults; uncommon

Sources: Morihara and Balsbaugh (1976)

Elymana sp.Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Rare; adults; polyphagous

Sources: Morihara and Balsbaugh (1976)

Empoasca sp.Plant recs.: *Carduus pycnocephalus* (S. Calif.); *C. nutans* (S. Dak.)

Remarks: Rare; nymphs and adults ectophagous on leaves

Sources: Goeden (1974); Morihara and Balsbaugh (1976)

Endria inimica (Say)Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Nymphs and adults abundant; polyphagous crop pest; vector of aster yellows and wheat streak mosaic

Sources: Morihara and Balsbaugh (1976)

Euscelis lineolatus BrullePlant recs.: *Carduus pycnocephalus* (S. Europe)

Remarks: Rare; adults on leaves; polyphagous

Sources: Goeden (1974)

Graphocephala coccinea Forster

Plant recs.: *Carduus nutans* (S. Dak.)
 Remarks: Rare; adults; polyphagous
 Sources: Morihsara and Balsbaugh (1976)

Latalus sp.

Plant recs.: *Carduus nutans* (S. Dak.)
 Remarks: Rare; adults; polyphagous
 Sources: Morihsara and Balsbaugh (1976)

Macrosteles divisa (Uhler)

Plant recs.: *Carduus nutans* (S. Dak.)
 Remarks: Adults ectophagous on Compositae; crop pest
 Sources: Morihsara and Balsbaugh (1976)

Neosteles neglecta Delong and Davidson

Plant recs.: *Carduus nutans* (S. Dak.)
 Remarks: Nymphs and adults ectophagous
 Sources: Morihsara and Balsbaugh (1976)

Paragonia tredecimpunctata Ball

Plant recs.: *Carduus pycnocephalus* (S. Calif.)
 Remarks: Nymphs and adults common; ectophagous on leaves and stems; polyphagous
 Sources: Goeden (1974)

Paraphlepsius irroratus (Say)

Plant recs.: *Carduus nutans* (S. Dak.)
 Remarks: Adults, nymphs moderately abundant; polyphagous
 Sources: Morihsara and Balsbaugh (1976)

Psammotettix sp.

Plant recs.: *Carduus nutans* (S. Dak.)
 Remarks: Rare; adults
 Sources: Morihsara and Balsbaugh (1976)

Aphididae

Unident. aphid spp.

Plant recs.: *Carduus edelbergii* (Pakistan); *C. nutans* (Europe); *C. pycnocephalus* (Egypt)
 Remarks: None
 Sources: A17-ENT-9 Rpt. (1961); Zwölfer (1965a); F4-ENT-5 Rpt. (1967)

Aphis spp. (2)

Plant recs.: *Carduus nutans* (S. Dak.)
 Remarks: Adults and nymphs; ectophagous on stems
 Sources: Morihsara and Balsbaugh (1976)

Aphis craccivora Koch (= *A. medicaginis* (Koch))

Plant recs.: *Carduus pycnocephalus* (France, S. Europe); *Tribulus*, *Cnicus* (Pakistan)

HEMIPTERA-HOMOPTERA—Continued

Aphididae—Continued

Remarks: Winter host is *Robinia*; polyphagous

Sources: L. Andres in litt. (1961); A17-ENT-9 Rpt. (1965); Goeden (1974)

Aphis fabae Scopoli

Plant recs.: *Carduus pycnocephalus* (S. Calif.)

Remarks: Occasional nymphs and adults; reproduce on leaves and stems; polyphagous crop pest

Sources: Goeden (1974)

Aphis gossypii Glover

Plant recs.: *Carduus pycnocephalus* (S. Calif.)

Remarks: Occasional nymphs and adults on flowers, leaves, and stems; polyphagous crop pest

Sources: Goeden (1974)

Brachycaudus sp.

Plant recs.: *Carduus edelbergii* (Pakistan)

Remarks: Nymphs and adults feeding on leaves of *Carduus*

Sources: A17-ENT-9 Rpt. (1965)

Brachycaudus cardui (L.) (= *Anuraphis cardui*, *Aphis cardui*)

Plant recs.: *Carduus pycnocephalus* (France, Italy); *C. nutans* (Italy); *Carduus* sp. (Va.); *C. edelbergii*, *Cnicus* (Pakistan); *Cynara*, *Cirsium*, *Senecio*

Remarks: Locally common on flowers and stems; winter host is *Prunus*

Sources: L. Andres in litt. (1961); Baloch et al. (1971); Goeden (1974); L. T. Kok in litt. (1976)

Brachycaudus helichrysi Kaltenbach (= *Aphis helichrysi* (Kalt.))

Plant recs.: *Carduus pycnocephalus* (Egypt, S. Calif.)

Remarks: This species severely infests growth of blooming *Carduus* in Egypt and is preyed on by the cecidomyiid *Phaenobremia aphidivora* Rubs.; *B. helichrysi* also is known in N. and S. Amer., Europe, S. Asia, and N. Africa; winter host is *Prunus*; summer hosts are artichoke, sugar beets, clover, aster, chrysanthemum, iris, petunia, almond, apricot, peach, plum, and others

Sources: F4-ENT-5 Rpts. (1966–67); Goeden (1974)

Capitophorus carduinus (Walker) (= *C. flaveolus* (Walk.))

Plant recs.: *Carduus nutans*, *C. acanthoides*, *C. crispus*, *Cirsium* (Europe); *Cirsium* (Canada); *Cynara* (USA)

Remarks: Reported on foliage of *Carduus*; on *Cirsium* all year

Sources: Zwölfer (1965a); Maw (1976)

Capitophorus elaeagni (del Guercio) (= *C. braggii* Gillette)

Plant recs.: *Carduus edelbergii* (Pakistan); *C. pycnocephalus* (S. Calif.); *Cirsium* (Canada)

Remarks: Nymphs and adults feeding on leaves of *Carduus*; summer hosts are several Compositae including *Cynara*; winter hosts are *Elaeagnus hippophae* and *Shepherdia*

Sources: A17-ENT-9 Rpt. (1965); Baloch et al. (1971); Goeden (1974); Maw (1976)

Capitophorus flaveolus Walker

Plant recs.: *Carduus acanthoides* (Europe); *Cirsium*

Remarks: Stenophagous

Sources: Zwölfer (1965a)

Cerosiphia wartenbergi Borner

Plant recs.: *Carduus defloratus* (Europe)

Remarks: None

Sources: Zwölfer (1965a)

Dactynotus aeneus (Hille Ris Lambers)

Plant recs.: *Carduus nutans*, *C. defloratus*, *C. acanthoides*, *C. crispus* all year (Europe); *Cirsium* (Europe)

Remarks: Nymphs and adults on leaves and stems

Sources: Zwölfer (1965a)

Dactynotus jaceae (L.) (= *Macrosiphum jaceae* (L.))

Plant recs.: *Carduus pycnocephalus* (Italy); *Carthamus*, *Cirsium*, *Campanula* (Europe, Rhodesia, India, Egypt)

Remarks: Nymphs and adults locally common on flowers and stems; on *Centaurea* all year

Sources: L. Andres in litt. (1961); Goeden (1974)

Dactynotus macrosiphon (Hille Ris Lambers)

Plant recs.: *Carduus defloratus*, *C. personatus*, *Cirsium*, *Carlina* (Europe)

Remarks: Nymphs and adults on stems and leaves

Sources: Zwölfer (1965a)

Rhopalosiphum sp.

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Nymphs, adults ectophagous on stems

Sources: Morihara and Balsbaugh (1976)

Toxopterina acanthoides (Borner)

Plant recs.: *Carduus acanthoides* (Europe)

Remarks: Nymphs and adults on leaves and stems

Sources: Zwölfer (1965a)

Cercopidae

Unident. cercopid spp.

HEMIPTERA-HOMOPTERA—Continued

Cercopidae—Continued

Plant recs.: *Carduus pycnocephalus* (S. Calif., S. Europe)

Remarks: Nymphs locally common to rare on stems; ectophagous

Sources: Goeden (1974)

Philaenus spumarius (L.)

Plant recs.: *Carduus pycnocephalus* (S. Europe)

Remarks: Nymphs and adults on shoots; polyphagous

Sources: Goeden (1974)

Delphacidae

Unident. delphacid sp.

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Nymphs and adults; ectophagous

Sources: Morihara and Balsbaugh (1976)

Dictyopharidae

Orgerius concordus Ball and Hartzell

Plant recs.: *Carduus pycnocephalus* (S. Calif.)

Remarks: Rare; adults on shoots; polyphagous

Sources: Goeden (1974)

Issidae

Danepteryx sp. nr. *D. manca* Uhler

Plant recs.: *Carduus pycnocephalus* (S. Calif.)

Remarks: Rare; adults on leaves; polyphagous

Sources: Goeden (1974)

Acanaloniidae

Acanalonia bivittata (Say)

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Rare; adults; polyphagous

Sources: Morihara and Balsbaugh (1976)

Pseudococcidae

Unident. pseudococcid sp.

Plant recs.: *Carduus pycnocephalus* (S. Calif.)

Remarks: Rare; nymphs on leaves

Sources: Goeden (1974)

COLEOPTERA

Staphylinidae

Mesomorphus sp.

Plant recs.: *Carduus edelbergii* (Pakistan)

Remarks: Adults; feeding on leaves

Sources: A17-ENT-9 Rpt. (1965); Baloch et al. (1971)

Melyridae

Unident. melyrid spp.

Plant recs.: *Carduus pycnocephalus* (S. Calif.)

Remarks: Adults; locally common on flowers

Sources: Goeden (1974)

Procerallus (= *Acanthocnemus*) *altivolans* Champ.

Plant recs.: *Carduus edelbergii* (Pakistan)

Remarks: Adults taken from flowers; no other hosts known

Sources: A17-ENT-9 Rpts. (1962-63, 1965)

Phalacridae

Phalacrus sp.

Plant recs.: *Carduus edelbergii* (Pakistan)

Remarks: Adults found on plant; occasional visitors; no other host known

Sources: A17-ENT-9 Rpt. (1965); Baloch et al. (1971)

Nitidulidae

Unident. nitidulid sp.

Plant recs.: *Carduus acanthoides* (France)

Remarks: Larvae in flower heads

Sources: Delémont Rpt. (1963)

Meligethes sp.

Plant recs.: *Carduus edelbergii* (Pakistan)

Remarks: Adults feeding on flowers; polyphagous; a polyphagous *Meligethes* also known from "thistles" in Europe

Sources: A17-ENT-9 Rpts. (1962-63, 1965); Baloch et al. (1971)

Meligethes nigrescens Stephens

Plant recs.: *Carduus pycnocephalus* (S. Europe)

Remarks: Rare; adults endophagous in flowers

Sources: Goeden (1974)

Oedemeridae

Oedemera sp.

Plant recs.: *Carduus nutans* (Austria); *C. crispus* (Rhine Valley)

Remarks: Ovipositing in stems of *C. nutans*; adult on leaves of *C. crispus*

Sources: Delémont Rpts. (1962-63)

Mordellidae

Unident. mordellid sp.

Plant recs.: *Carduus acanthoides* (France); *C. crispus* (Rhine Valley); *C. nutans*, *C. tenuiflorus* (Europe)

Remarks: Larvae on leaves of *C. acanthoides*, in stems of *C. crispus*, *C. nutans*, and *C. tenuiflorus*

Sources: Delémont Rpt. (1963); Zwölfer (1965a)

COLEOPTERA—Continued

Mordellidae—Continued

Mordella sp.Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Adults; larvae endophagous in leaves and stems

Sources: Morihara and Balsbaugh (1976)

Mordellistena spp.Plant recs.: *Carduus nutans* (Rhine Valley, S. Dak.); *C. crispus* (Europe); *C. pycnocephalus* (S. Calif.)Remarks: Larvae in stems of *C. nutans* and listed as endophytic in stems of *C. crispus*; adults occasional on leaves, stems, and flowers

Sources: Delémont Rpt. (1963); Zwölfer (1965a); Goeden (1974); Morihara and Balsbaugh (1976)

Meloidae

Epicauta atrata (F.)Plant recs.: *Carduus nutans* (Sask.)

Remarks: None

Sources: M. G. Maw in litt. (1976)

Epicauta ferruginea (Say)Plant recs.: *Carduus nutans* (Sask.)

Remarks: None

Sources: M. G. Maw in litt. (1976)

Nemognatha lutea LeContePlant recs.: *Carduus nutans* (Sask.)

Remarks: None

Sources: M. G. Maw in litt. (1976)

Alleculidae

Unident. alleculid sp.

Plant recs.: *Carduus nutans* (Europe)

Remarks: Occasional visitor

Sources: Zwölfer (1965a)

Byturidae

Unident. byturid sp.

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Rare; larva

Sources: Morihara and Balsbaugh (1976)

Anobiidae

Lasioderma sp.Plant recs.: *Carduus pycnocephalus* (S. Europe)

Remarks: Larvae common; endophagous in flowers; also in other Cynareae

Sources: Goeden (1974)

Lasioderma baudii Schilsky

Plant recs.: *Carduus pycnocephalus*, *C. tenuiflorus* (Italy);
Cirsium, *Centaurea*, *Cynara*, *Carthamus*

Remarks: Larvae reared from capitula, feed in seeds;
 first identified as *L. serricorne*

Sources: Rome Rpts. (1963–64)

Lasioderma redtenbacheri Bach

Plant recs.: *Carduus nutans*, *Onopordum*, *Centaurea* (Europe);
Centaurea (Egypt)

Remarks: Larvae endophytic in flower heads and buds;
 main hosts in Egypt listed as chestnuts;
 distrib. Sicily and Egypt

Sources: Zwölfer (1965a); F4-ENT-5 Rpt. (1967)

Lasioderma serricorne (F.)

Plant recs.: *Carduus nutans*, *C. tenuiflorus*, *Centaurea*, *Cynara*
 (Italy); *Centaurea* (France, Egypt); *Silybum*
 (Lebanon)

Remarks: Some earlier recs. (by Rome) are *L. bauddii*; lar-
 vae feed in receptacle and are probably second-
 ary in their attack following weevils and seed
 flies; numerous reports of attacking *Cynara*,
 following *L. baudii* in Italy

Sources: Rome Rpts. (1963–64); Delémont Rpt. (1965); F4-
 ENT-5 and F4-ENT-16 Rpts. (1967–68, 1976)

Scarabaeidae

Cetonia aurata (L.)

Plant recs.: *Carduus pycnocephalus* (S. Europe)

Remarks: Rare; adults in flowers; polyphagous

Sources: Goeden (1974)

Oxythyrea sp.

Plant recs.: *Carduus edelbergii* (Pakistan)

Remarks: Adults found in flowers; occasional visitor

Sources: A17-ENT-9 Rpts. (1961–62, 1965); Baloch et al.
 (1971)

Oxythyrea funesta Poda

Plant recs.: *Carduus nutans*, *C. pycnocephalus*, *Cirsium*, *Cen-*
taurea, *Onopordum* (Europe)

Remarks: Occasional visitor on thistles; adults common
 on flowers; polyphagous

Sources: Zwölfer (1965a); Goeden (1974)

Potosia hungarica Herbst

Plant recs.: *Carduus nutans*, *C. acanthoides*, *Cirsium* (Europe)

Remarks: Occasional visitor on thistles

Sources: Zwölfer (1965a)

COLEOPTERA—Continued

Scarabaeidae—Continued

Potosia morio (F.)Plant recs.: *Carduus pycnocephalus* (S. Europe)Remarks: Occasional adults feeding on flowers;
polyphagous

Sources: Goeden (1974)

Tropinota hirta (Poda)Plant recs.: *Carduus nutans* (Europe); *C. pycnocephalus* (S. Europe)Remarks: Rare; occasional visitor; adults ectophagous
on flowers; polyphagous

Sources: Zwölfer (1965a); Goeden (1974)

Tropinota squalida ScopoliPlant recs.: *Carduus pycnocephalus* (Egypt)

Remarks: None

Sources: F4-ENT-5 Rpts. (1967, 1971)

Cerambycidae

Unident. cerambycid spp.

Plant recs.: *Carduus nutans*, *C. pycnocephalus*, *C. tenuiflorus*,
Silybum, *Onopordum* (adults only, Italy); *C. nutans* (larvae, Italy)Remarks: Small adults found on these plants with no
associated larvae; large larvae commonly
found boring in pith of larger stems of *C. nutans*, but apparently predaceous

Sources: Rome Rpt. (1963)

Agapanthia sp.Plant recs.: *Carduus crispus* (Rhine Valley)

Remarks: Larvae endophytic in stems

Sources: Delémont Rpt. (1963); Zwölfer (1965a)

Agapanthia cardui (L.)Plant recs.: *Carduus nutans* (Rhine Valley); *C. nutans*, *C. acanthoides*, *C. tenuiflorus*, *C. pycnocephalus*, *Cirsium*, *Galactites*, *Onopordum*, *Centaurea*, *Cynara* (Europe); ? *Centaurea* (France, Bulgaria)Remarks: Larvae (endophytic in stem) reared only from
Cirsium; other recs. here are adults only (on
foliage); identity of larvae in *Centaurea* in
France and Bulgaria in question, given as
“possibly *cardui*”Sources: Delémont Rpts. (1963, 1965, 1967); Zwölfer
(1965a); Goeden (1974)

Agapanthia dahli Richter

Plant recs.: *Carduus nutans* (Austria); *C. nutans*, *C. acanthoides*, *C. pycnocephalus*, *C. litigiosus*, *Cirsium*, *Arctium* (Europe); *Carduus pycnocephalus*, *Centaurea* (Egypt)

Remarks: Larvae (feeding in stem) reared only from *Carduus acanthoides*, *C. pycnocephalus*, and *Centaurea*; other recs. shown here are adults only (feeding on foliage); *A. dahli* studied in lab. at Delémont; reared in lab. in Egypt from *C. pycnocephalus* and *Centaurea*; one of main pests of *C. pycnocephalus* in Egypt; an economic pest of sunflower in USSR

Sources: Delémont Rpt. (1963); CIBC Ann. Rpt. (1963); Zwölfer (1965a); F4-ENT-5 and F4-ENT-16 Rpts. (1967, 1976); Goeden (1974)

Agapanthia lateralis Ganglbauer

Plant recs.: *Carduus pycnocephalus*, *Centaurea*, *Silybum* (Egypt)

Remarks: One of main pests of *C. pycnocephalus* in Egypt; reared in lab. in Egypt from *C. pycnocephalus* and *Centaurea*; larvae feed in stems

Sources: F4-ENT-5 and F4-ENT-16 Rpts. (1967-68, 1976)

Agapanthia villosoviridescens De Geer

Plant recs.: *Carduus nutans*, *C. pycnocephalus*, *Cirsium*, *Onopordum*, *Echinops* (Europe)

Remarks: Larvae (feeding in stems) recorded only from *Cirsium* and *Echinops*; other recs. here are adults only, eating stems or foliage; literature rec. hosts are *Angelica*, *Aconitum*, *Eupatorium*, *Heracleum*, *Senecio*, and *Cirsium*

Sources: Delémont Rpts. (1962-63); Zwölfer (1965a); Goeden (1974)

Agapanthia violacea (F.)

Plant recs.: *Carduus pycnocephalus*, *Centaurea* (Europe)

Remarks: Occasional visitor (adults)

Sources: Zwölfer (1965a)

Purpuricenus kaehleri (L.)

Plant recs.: *Carduus pycnocephalus* (S. Europe)

Remarks: Rare; adults ectophagous on flowers; polyphagous

Sources: Goeden (1974)

COLEOPTERA—Continued

Chrysomelidae

Unident. chrysomelid spp.

Plant recs.: *Carduus pycnocephalus* and/or *C. tenuiflorus* (Calif.)

Remarks: Feeding habits unknown

Sources: Albany Rpt. (1963)

Altica sp. nr. *A. viridicyanea* Baly (= *Haltica* sp.)Plant recs.: *Carduus edelbergii* (Pakistan)Remarks: Adults feeding on foliage; possibly oligophagous; morphologically different from European *Altica* spp.

Sources: A17-ENT-9 Rpt. (1965); Baloch et al. (1971)

Altica carduorum Guérin-MénevillePlant recs.: *Carduus pycnocephalus*, *C. nutans*, *C. crispus*, *C. tenuiflorus*, *C. defloratus*, *C. personatus*, *C. acanthoides*, *Cirsium*, *Silybum*, *Onopordum*, *Cnicus*, *Arctium*, *Xeranthemum*, *Cynara*, *Echinops*, *Helianthus*, *Chrysanthemum*, *Carthamus*, *Lactuca*, flax (Europe and lab. recs. – see remarks)Remarks: Adults and larvae skeletonize leaves of host, desiccating plant incl. roots; believed to be host specific to *Cirsium*, with *Carduus* and *Silybum* being marginal hosts, probably not in natureField recs. (adults only); *Cirsium arvense* (L.) Scop. (Switzerland, France, Spain), *C. vulgare* (Savi) Ten. (Spain), and *Carduus pycnocephalus* (Europe)

Other distrib. (from museum specimens): Germany, Czechoslovakia, Yugoslavia, Greece, Albania, Italy, Sicily, Sardinia, Corsica, Cyprus, ?Austria, and ?Asiatic USSR

History: First discovered in Swiss Valais, May 1961; shipped to Canada, 1962–64; Working Group on Biological Control of Weeds approved release in Canada, Mar. 1963, in U.S., 1966; released in Canada, 1963–70; released in U.S., 1966–72; insect studied and released to control Canada thistle (*Cirsium arvense*)Results of lab. screening tests (D = Delémont, B = Belleville, A = Albany): Adults fed regularly on *Carduus nutans* (D), *C. crispus* (D), *C. tenuiflorus* (D), *C. acanthoides* (B), *C. sp.* prob.

tenuiflorus (A), *C. pycnocephalus* (A), *Cirsium* (D, B, A), *Silybum* (D, B, A), and occasionally on *Carduus defloratus* (D), *C. personatus* (D), *Cnicus* (D), *Arctium* (D, B), *Xeranthemum* (B), *Onopordum* (D, B), *Centaurea* (B, A), *Helianthus* (B), *Chrysanthemum* (B), *Lactuca* (A), and especially the new tender growth of *Carthamus* (A) and *Cynara* (A); larvae fed and developed successfully only on *Carduus acanthoides* (B), *C. pycnocephalus* (A), *Cirsium* (D, B, A), and *Silybum* (D, B); fed occasionally, but could not develop on *Cnicus* (D), *Xeranthemum* (D), *Cynara* (D, A), *Centaurea* (B), *Onopordum* (B), *Echinops* (B), *Carthamus* (A), and flax; eggs deposited only on *Cirsium* (D, B, A) and *Silybum* (D, ?B, A); detailed results of specificity tests in Harris (1964); distrib. and ecology in Zwölfer (1965b)

Releases (A = adults, L = larvae) against *Cirsium arvense*: Canada - 21 A in Ont. and 100 A and L in Alta. in 1963; 600 A and L in Ont. (2 locs.), and 100 A and L in B.C. (82 A and L sent to Albany for lab.) in 1964; 149 A in Alta., 72 A in B.C., and 1,460 A and L in Ont. (2 locs.) in 1965; 60 A in N.S. and 35 A (+ 482 L in field cage study) in Ont. in 1966; 367 ?A (+ 64 in field cage study) in B.C. and 490 ?A in Ont. in 1967; 1,147 A in B.C. (2 locs.), 1,160 A and 107 L in Alta., and 291 A in Ont. in 1968; 5,534 A in B.C. (2 locs.) and 170 A in Alta. in 1969; and 1,363 A (from lab. culture and France); in Ont. (2 locs.) in 1970

United States - 1,000 A in Calif. (4 locs.), 400 A in Idaho, 200 A in Oreg., 200 A in Wash., and in Mont. (640 A sent, but prob. only 200 released, 2 locs.) in 1966; 1,700 A in Calif. (Ft. Bragg area) and 175 in Idaho (in field cage) in 1967; 500 A in Calif. (Ft. Bragg field cage), 150 A in Colo. (2 locs.), 200 A in Idaho, 100 A in Wash., 200 A in Minn., 200 A in Wis., 200 A in Ind., 200 A in Del., and 200 A (+ some larvae reared in lab.) in N.J. in 1968; unknown No. A in Calif. (Ft. Bragg area) in 1969; 500 A and 242 L in S. Dak. (field cages) and 360 L in Md. (field

cages) in 1970; 160 A in Md. and 65 sent to S. Dak. in 1971; and 52 A sent to S. Dak. in 1972 (S. Dak. and Md. releases from French material)

Recovery data: Little survival in Canada, not established on *Cirsium* in B.C., Alta., Ont., or N.S. by 1975 and studies discontinued; possible reasons are predation and low summer temperatures; no overwintering observed at Ft. Bragg, Calif., release site; no known establishment elsewhere in U.S.; in Canada, it survived only when protected by field cages from predation; the mites *Leptus* sp. nr. *curtipes* Schweitzer and *Sphaerolophus* sp. ate the eggs (Peschken et al., 1971); over 2,100 adults were released in 1969 at 3 sites in England (Claridge et al., 1970); poor survival in cages was attributed to the cool climate (Baker et al., 1972); in S. Dak., establishment was limited by the hot, dry summers and predation by *Lebia viridis* Say and *Harpalus pennsylvanicus* De Geer (Schaber et al. 1975)

Sources: Delémont Rpts. (1961–65, 1967); Belleville Res. Inst. Res. Rpts. (1962–63); CIBC Ann. Rpts. (1963–64, 1969, 1970); Karny (1963); Albany Rpts. (1964–72); Harris (1964, 1975); Zwölfer (1965a, b); R. B. Hawkes in litt. (1966); Williamson (1966–70); Canada Dept. Agr. Res. Inst. Res. Rpt. (1966); Zwölfer and Harris (1966); ARS Lab., Moorestown, N.J., Rpt. (1968); Zwölfer (1969, 1970); Zwölfer and Pattullo (1970); Peschken et al. (1970); Andres and Davis (1973); Goeden (1974); Maw (1976)

Aphthona pygmaea Kutschera

Plant recs.: *Carduus pycnocephalus* (S. Europe)

Remarks: Rare; adults on leaves

Sources: Goeden (1974)

Arima marginata (F.)

Plant recs.: *Carduus nutans*, *Centaurea* (France); other hosts from literature: *Carduus*, *Cirsium*, *Onopordum*, *Arctium*, Asteraceae, Heliantheae, Anthemideae, Calenduleae, Centaureinae, *Lactuca* (lab. tests)

Remarks: Adults and larvae on leaves

Sources: Grandi (1952); Heikertinger (1954); Zwölfer (1969)

Cassida deflorata Suffrian

Plant recs.: *Carduus tenuiflorus*, *C. personatus*, *C. pycnocephalus*, *C. defloratus*, *C. nutans*, *C. crispus*, *Cnicus*, *Arctium*, *Cynara*, *Cirsium*, *Onopordum*, *Silybum*, *Centaurea*, *Chrysanthemum*, *Echinops*, *Xeranthemum*, *Carthamus*, *Carlina*, *Tagetes*, *Leontodon*, *Erigeron* (Europe and in lab. tests – see remarks)

Remarks: Field recs.: *Carduus* sp., *C. tenuiflorus*, *C. pycnocephalus* (S. Europe), *Cynara*, *Silybum* (France), *Cirsium* (Switzerland), and *Cynara* (Italy); adults and larvae on all species here except on *C. tenuiflorus* (adults and eggs only) and on *Cirsium* in Switzerland (adults only); identity of "sp. prob. *deflorata*" in Italy on *Cynara* in question

Results of lab. tests (Delémont): Adults fed heavily or regularly on foliage of *Carduus personatus*, *C. defloratus*, *C. nutans*, *C. tenuiflorus*, *C. crispus*, *Arctium*, *Cynara*, *Onopordum*, *Silybum*, *Cirsium*, *Centaurea*, and rather inconsistently or occasionally on *Cnicus*, *Chrysanthemum*, *Carthamus*, *Echinops*, *Xeranthemum*, and *Carlina*; larvae fed regularly on *Carduus* (same 5 spp. as above), *Cnicus*, *Carthamus*, *Arctium*, *Cynara*, *Onopordum*, *Silybum*, *Centaurea*, and inconsistently or occasionally on *Echinops*, *Xeranthemum*, *Tagetes*, and *Leontodon*; adults show high feeding indices in *Cynara* and *Onopordum*; cannot be considered in biological control program because of feeding on *Cynara*

Sources: Delémont Rpts. (1961–63); Zwölfer (1965a, 1969); Zwölfer and Eichhorn (1966); Goeden (1974)

Cassida rubiginosa Mueller

Plant recs.: *Carduus pycnocephalus*, *C. acanthoides*, *C. defloratus*, *C. crispus*, *C. nutans*, *C. personatus*, *C. tenuiflorus*, *Cirsium*, *Onopordum*, *Arctium*, *Centaurea*, *Carthamus*, *Cynara*, *Silybum*, *Lappa*, *Tanacetum*, *Xeranthemum*, *Cnicus*, *Echinops*, *Helianthus*, *Erigeron*, *Solidago*, *Aster*, *Carlina*, *Taraxacum* (Europe, N. Amer., and in lab. tests – see remarks)

COLEOPTERA—Continued

Chrysomelidae—Continued

Remarks: Adults and larvae skeletonize and severely damage leaves of hosts; prefer *Cirsium*, *Carduus*, and *Silybum*, but also feed on *Cynara*, *Carthamus*, and other plants

Field recs.: Adults and larvae from *Carduus nutans* and *C. pycnocephalus* (Europe), *C. thoermeri* and *C. nutans* (abundant in N. Va., Md., Pa., 1975), *C. crispus* (Rhine Valley), *C. personatus* (Europe), *C. acanthoides* (Swabian Jura), *C. defloratus* (Switzerland), *Carduus* (Canada), *Cirsium* (Switzerland, Canada, France, Swabian Jura, Rhine Valley), and *Onopordum*, *Arctium*, and *Centaurea* (Europe); adults only from *Carduus acanthoides* and *Onopordum* (France), *Carduus nutans* and *Cirsium* (Austria), and *Carduus defloratus* and *C. personatus* (Europe); unknown stages from *C. pycnocephalus* (France, Italy), *Cirsium*, *Lappa*, and *Silybum* (N. Amer.)

Other distrib.: Germany, England, Ont. (found 1927), Que. (1940), N.Y. (1945), and N.J. (1962)

Results of lab. screening tests (Delémont, 1962–63): Adults fed regularly on *Carduus personatus*, *C. defloratus*, *C. nutans*, *C. tenuiflorus*, *C. crispus*, *Cirsium*, *Silybum*, *Onopordum*, *Cynara*, *Arctium*, *Centaurea*, *Carthamus*, and occasionally (or nibbled) on *Xeranthemum*, *Cnicus*, *Echinops*, and *Helianthus*; larvae fed and developed on same 5 *Carduus* spp. in adult test plus *Cirsium*, *Silybum*, *Onopordum*, *Cynara*, *Arctium*, *Centaurea*, and fed but did not develop on *Carthamus*, *Cnicus*, *Echinops*, and *Erigeron*; oviposition obtained on *Carduus defloratus*, *C. nutans*, *Cirsium*, *Silybum*, *Onopordum*, *Cynara*, *Arctium*, *Centaurea*, *Carthamus*, *Cnicus*, *Helianthus*, *Erigeron*, *Solidago*, *Aster*, *Carlina*, and *Taraxacum* (fate of eggs not studied in this test); parasitism may prevent high populations in parts of N. Amer.

Sources: L. Andres in litt. (1961); Delémont Rpts. (1962–63, 1967); Rome Rpt. (1963); Zwölfer

(1965a, 1969); Zwölfer and Eichhorn (1966); Mohr (1966); Zwölfer and Pattullo (1970); S. W. T. Batra and L. T. Kok in litt. (1976); Maw (1976)

Cassida sp. nr. *C. vibex* (L.)

Plant recs.: *Carduus* sp. (Austria, Switzerland); *C. acanthoides* (Switzerland); *C. personatus* (France); *C. edelbergii* (Pakistan)

Remarks: Eggs and larvae found on plants in Europe; adults feeding on leaves of *C. edelbergii* in Pakistan

Sources: Delémont Rpts. (1962-63); A17-ENT-9 Rpt. (1965); Zwölfer and Eichhorn (1966); Baloch et al. (1971)

Cassida vibex (L.)

Plant recs.: *Carduus defloratus*, *C. crispus*, *C. pycnocephalus*, *C. tenuiflorus*, *C. nutans*, *C. personatus*, *Cirsium*, *Centaurea*, *Arctium*, *Onopordum*, *Silybum*, *Serratula*, *Cnicus*, *Carthamus*, *Cynara*, *Tanacetum*, *Xeranthemum*, *Echinops*, *Carlina*, *Helianthus*, *Chrysanthemum*, *Solidago*, *Erigeron*, *Aster*, *Taraxacum*, *Lactuca* (Europe and in lab. tests - see remarks)

Remarks: Adults and larvae skeletonize the leaves of the host; a potential pest of *Cynara* and *Carthamus*

Field recs.: Adults and larvae from *Carduus defloratus* and *Cirsium* (Switzerland, France, Austria, Rhine Valley), *Onopordum* and *Arctium* (France), and *Centaurea* and *Serratula* (Europe); adults only from *Carduus crispus*, *C. pycnocephalus*, *C. personatus*, *C. tenuiflorus*, and *Silybum* (Europe)

Results of lab. tests (Delémont, 1962-63) for *Cirsium arvense*: Adults fed heavily or regularly on *Carduus nutans*, *C. defloratus*, *C. tenuiflorus*, *C. crispus*, *C. personatus*, *Cirsium*, *Silybum*, *Centaurea*, *Onopordum*, *Cynara*, *Carthamus*, *Arctium*, *Cnicus*, and occasionally on *Xeranthemum*, *Echinops*, *Carlina*, and *Helianthus*; larvae fed and developed on *Carduus* (same 5 spp. as for adult test), *Cirsium*, *Silybum*, *Centaurea*, *Onopordum*, *Cynara*, *Carthamus*, *Cnicus*, and nibbled (but did not develop) on *Carlina* and *Chrysanthemum*; oviposition obtained (fate of eggs not studied) on *Carduus defloratus*, *Cirsium*,

Silybum, Centaurea, Onopordum, Cynara, Arcium, Cnicus, Xeranthemum, Echinops, Chrysanthemum, Solidago, Erigeron, Aster, Taraxacum, and Lactuca

Sources: Delémont Rpts. (1961, 1963); Zwölfer (1965a, 1969); Zwölfer and Eichhorn (1966); Mohr (1966)

Chaetocnema confinis Crotch

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Adults ectophagous on leaves; polyphagous crop pest

Sources: Morihara and Balsbaugh (1976)

Chrysomela banksi F.

Plant recs.: *Carduus pycnocephalus* (S. Europe); Compositae, Labiatae

Remarks: Rare; adults on leaves; prob. polyphagous

Sources: Zwölfer (1969); Goeden (1974)

Chrysomela fuliginosa Olivier

Plant recs.: *Centaurea* (Europe); *Carduus nutans*, *Cirsium*, *Cynara*, *Cnicus*, *Carthamus*, *Centaurea* (lab. tests)

Remarks: Adults and larvae on leaves

Sources: Zwölfer (1969)

Crepidodera ferruginea Scopoli

Plant recs.: *Carduus defloratus*, *C. personatus*, *Cirsium*, *Carlina*, other Compositae (Europe)

Remarks: These recs. are adults only on foliage; larvae generally attack plant stem base

Sources: Zwölfer (1965a, 1969)

Crepidodera transversa Marsham

Plant recs.: *Carduus defloratus*, *Cirsium*, *Carlina* (Austria, Switzerland)

Remarks: These recs. are adults only on foliage; oviposition and screening tests conducted with this sp. at Delémont in 1962 and 1963

Sources: Delémont Rpts. (1962-63)

Cryptocephalus sericeus (L.)

Plant recs.: *Carduus nutans* (Europe)

Remarks: Occasional visitor

Sources: Zwölfer (1965a)

Diabrotica undecimpunctata undecimpunctata Mannerheim

Plant recs.: *Carduus pycnocephalus* (S. Calif.)

Remarks: Occasional adults; poss. breeding on flowers, leaves, and stems; polyphagous crop pest

Sources: Goeden (1974)

Diachus auratus (F.)

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Adults on leaves; polyphagous

Sources: Morihara and Balsbaugh (1976)

Enneameria variabilis Baly

Plant recs.: *Carduus edelbergii* (Pakistan)

Remarks: Adults exophytic on stems and leaves

Sources: Baloch et al. (1971)

Epithrix cucumeris (Harris)

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Adults on leaves; polyphagous crop pest

Sources: Morihara and Balsbaugh (1976)

Galeruca pomonae (Scopoli)

Plant recs.: *Carduus crispus*, *C. nutans*, *C. defloratus*, *C. personatus* (in lab. tests only); *Centaurea*, *Cirsium*, *Carlina* (Europe)

Remarks: Adults and larvae feed on leaves of host, often causing defoliation; *Centaurea* believed to be main host plant

Field recs.: Larvae reared from *Centaurea* (Switzerland); adults and larvae found from *Cirsium* and *Carlina* (Europe)

Results of lab. tests (Delemont, 1962-63) for *Cirsium arvense*: Adults fed heavily or regularly on *Carduus crispus*, *Centaurea*, *Cirsium*, *Arctium*, *Cnicus*, and occasionally on *Carduus nutans* and *C. defloratus*; larvae fed heavily or regularly on *C. nutans*, *C. personatus*, *Achillea*, *Silybum*, *Centaurea*, *Cnicus*, *Cynara*, *Cirsium*, and occasionally on *Carduus defloratus*

Sources: Delémont Rpts. (1962-63); Zwölfer, (1965a, 1969); Mohr (1966)

Galeruca tanaceti (L.)

Plant recs.: *Carduus nutans* (Europe); *C. defloratus* (in lab. tests only); *Achillea* (Switzerland and in lab. tests); *Cirsium* (Switzerland, France, Swabian Jura, and in lab. tests); *Centaurea* (Europe and in lab. tests); *Rudbeckia*, *Solidago*, *Erigeron*, *Aster*, *Chrysanthemum*, *Xeranthemum*, *Silybum*, *Helianthus* (in lab. tests only)

Remarks: Adults and larvae feed externally on foliage; apparently relatively polyphagous; these field recs. are all of adults and larvae except *Carduus nutans* (adults only)

Results of lab. tests (Delémont, 1962–63) for *Cirsium arvense*: Adults fed heavily or regularly on *Carduus defloratus*, *Rudbeckia*, *Achillea*, *Cirsium*, *Centaurea*, *Solidago*, *Erigeron*, *Aster*, *Chrysanthemum*, *Xeranthemum*, *Silybum*, and occasionally on *Helianthus*

Sources: Heikertinger (1954); Delemont Rpts. (1962–63); Zwölfer (1965a, 1969)

Hoplasoma sexmaculata Hope

Plant recs.: *Carduus edelbergii* (Pakistan)

Remarks: Adults feeding on leaves

Sources: A17-ENT-9 Rpt. (1965); Baloch et al. (1971)

Lachnea cylindrica LeConte

Plant recs.: *Carduus pycnocephalus* (S. Europe)

Remarks: Rare; adults ectophagous on flowers; polyphagous

Sources: Goeden (1974)

Lema cirsicola Chujo (= *L. "cyanella"*, misident.)

Plant recs.: *Carduus nutans*, *Silybum*, *Cynara*, *Carthamus*, *Centaurea*, *Helianthus* (in lab. tests only); *Cirsium* (Japan and in lab. tests)

Remarks: Coll. from *Cirsium* in Japan, as "cyanella"

Results of lab. tests (Albany, 1971–72) for *Cirsium arvense* and *C. vulgare*, early tests as "cyanella": Adults fed readily on *Cirsium* and *Silybum* spp., and very much less on *Carduus nutans*, *Centaurea*, *Cynara*, *Carthamus*, and *Helianthus*; adults oviposited on *Cirsium*, *Silybum*, and *Carduus nutans*; some minimal larval feeding on *C. nutans*; since coll. only from *Cirsium* in shaded forest stands, value of this sp. as control for *Cirsium arvense* questionable

Sources: Albany Rpts. (1971–73)

Lema cyanella L. (= *L. puncticollis* Curtis)

Plant recs.: *Carduus defloratus*, *Silybum*, *Onopordum* (in lab. tests only); *Cirsium* (France, Switzerland, and in lab. tests)

Remarks: Adults and larvae feed on leaves of *Cirsium*

In lab. tests (Delémont, 1962–63, 1967 as *puncticollis*, *rugicollis*; 1964 as *puncticollis*, *ruficollis*, *rugicollis*; and 1967 as *cyanella*) for *Cirsium arvense*: Adults fed regularly on *Cirsium*, *Silybum*, *Carduus defloratus*, and occasionally on *Onopordum*; host plants apparently

limited to *Carduus*, *Cirsium*, and *Silybum*; also fed on *Cirsium arvense*, *C. occidentale*, and *Carduus nutans*; being tested in Sask., Canada (1976)

Sources: Delémont Rpts. (1962, 1964, 1967); CIBC Ann. Rpts. (1963, 1964); Zwölfer, (1965a, 1969); Zwölfer and Harris (1966); Zwölfer and Pattullo (1970); P. Harris pers. comm. (1976)

Leptinotarsa decemlineata (Say)

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Adults ectophagous on leaves; polyphagous crop pest

Sources: Morihara and Balsbaugh (1976)

Longitarsus ?testaceus (Melsheimer)

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Adults on leaves; feeds on other thistles

Sources: Morihara and Balsbaugh (1976)

Merista quadrifasciata Hope

Plant recs.: *Carduus edelbergii*, *Cnicus* (Pakistan)

Remarks: Adults feeding on leaves; no other host plants known

Sources: A17-ENT-9 Rpt. (1965); Baloch et al. (1971)

Monolepta signata Olivier

Plant recs.: *Carduus edelbergii* (Pakistan)

Remarks: Adults feeding on leaves; polyphagous on crops

Sources: A17-ENT-9 Rpt. (1965); Baloch et al. (1971)

Oulema melanopus (L.) (= *Lema melanopus* L.)

Plant recs.: *Carduus tenuiflorus* (France); *C. pycnocephalus* (S. Europe); *Centaurea* (Europe)

Remarks: Occasional visitor (adult); pest of grains in Europe and N. Amer.

Sources: Delémont Rpt. (1962); Zwölfer (1965a); Goeden (1974)

Psylliodes sp.

Plant recs.: *Carduus nutans* (Europe)

Remarks: Occasional visitor

Sources: Zwölfer (1965a)

Psylliodes chalcomera (Illiger)

Plant recs.: *Carduus acanthoides* (Germany); *C. nutans* and *C. pycnocephalus* (Germany, Italy, and in lab. tests); *C. crispus* (Italy); *Cynara*, *Carthamus*, *Centaurea* (in lab. tests only)

COLEOPTERA—Continued

Chrysomelidae—Continued

Remarks: Adults feed on leaves, eggs laid on soil, larvae bore in growing tips of host plants at the crown; of these field recs., only Italian recs. on *Carduus nutans* and *C. pycnocephalus* are definitely adults and larvae; rec. from *C. crispus* is adult only

Results of lab. tests (Rome, 1966–71) for *Carduus* spp.: Adults fed on *Carduus nutans*, *C. pycnocephalus*, *Cynara*, *Carthamus*, and *Centaurea*; oviposition obtained on *Carduus nutans*, *C. pycnocephalus*, *Cirsium*, *Silybum*, and *Cynara*; 1st instar larvae successfully transferred to *Carduus* spp., *Silybum*, and *Cirsium*; adults produced only on *C. nutans*, mature larvae on *Carduus* and *Cynara*; introduced in quarantine to USA (Albany, Calif.) in 1972 (600), 1973 (3,362), and 1974 (3,600)

In lab. tests (Albany, 1972–74) adults fed on 4 *Cirsium* spp.; oviposition and larval development on *Carduus nutans*, *Centaurea*, and *Cynara*; some pupation and adult emergence on *Cynara*; this insect rejected as biocontrol agent (Albany Rpt., 1974); gregarine parasite, in 79 percent of sample, influences oviposition behavior; *Microctonus* sp. also parasitic (Rome Rpt., 1971)

Sources: Heikertinger (1954); K. E. Frick in litt. (1966); Rome Rpts. (1966–74); Albany Rpts. (1972, 1974); Goeden (1974); Dunn and Rizza (1976)

Psylliodes punctulata Melsheimer

Plant recs.: *Carduus nutans* (Sask.)

Remarks: None

Sources: M. G. Maw in litt. (1976)

Sphaeroderma rubidum Graells (= *S. "rubrum"*)

Plant recs.: *Carduus pycnocephalus*, *C. crispus*, *C. personatus*, *Cirsium*, *Cynara*, *Galactites*, *Onopordum*, *Serratula*, *Centaurea*, *Arctium*, *Carthamus* (Europe and in lab. tests – see remarks)

Remarks: Adults feed externally on leaves; larvae mine leaves of host plants

Field recs.: Adults only (ident. questioned in all cases) from *Cirsium* (Rhine Valley), *Centaurea*, *Galactites*, *Onopordum*, and *Carduus*

pycnocephalus (S. France or N. Spain); larvae and adults from *Serratula*, *Cynara*, and *Centaurea* (Europe); stage unknown from *Cynara* (Italy)

Results of lab. tests (Delemont, 1963, 1965) for *Cirsium arvense*: Adults fed heavily or regularly on *Centaurea*, *Carthamus*, *Arctium*, *Cynara*, *Onopordum*, *Cirsium*, *Carduus crispus*, and *C. personatus*; *Centaurea* is apparently main host, but *Cynara* and *Carthamus* are heavily damaged; therefore not considered for biological control

Sources: Delémont Rpts. (1963–65); Rome Rpt. (1963); Zwölfer (1965a, 1969); Mohr (1966); Goeden (1974)

Sphaeroderma testaceum Weise

Plant recs.: *Carduus nutans*, *C. crispus*, *C. personatus*, *C. defloratus*, *Cirsium*, *Carlina*, *Onopordum*, *Silybum* (Europe and in lab. tests – see remarks)

Remarks: Adults feed on foliage; larvae mine leaves of host plants; apparently prefers *Carduus*, *Cirsium*, and *Silybum*; appears to be a promising biological control candidate

Field recs.: Adults (only) from *Carduus defloratus*, *C. nutans*, *C. personatus*, *Carlina* (Switzerland), *Carduus crispus* (Rhine Valley, poss. ovipositing), *Cirsium* (Switzerland, France), and *Onopordum* (Europe); larvae from *Carduus nutans* and *Cirsium* (Europe)

Results of lab. tests (Delemont, 1962–63) for *Cirsium arvense*: Adults fed heavily or regularly on *Carduus nutans*, *C. crispus*, *C. personatus*, *C. defloratus*, and *Cirsium*; some feeding on *Onopordum* and *Silybum*

Sources: Delémont Rpts. (1962–63, 1967); Zwölfer (1965a, 1969); Zwölfer and Harris (1966); Zwölfer and Pattullo (1970)

Systema blanda Melsheimer

Plant recs.: *Carduus pycnocephalus* (S. Calif.)

Remarks: Rare; adults feeding on leaves and stems; polyphagous crop pest

Sources: Goeden (1974)

Systema elongata (F.)

Plant recs.: *Carduus nutans* (S. Dak.)

COLEOPTERA—Continued

Chrysomelidae—Continued

Remarks: Rare; adults on leaves; polyphagous

Sources: Morihara and Balsbaugh (1976)

Systema frontalis (F.)

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Adults on leaves; polyphagous

Sources: Morihara and Balsbaugh (1976)

Curculionidae

Unident. curculionid spp.

Plant recs.: *Carduus acanthoides* (Austria, Switzerland); *C. nutans* (Italy)

Remarks: Feeding in roots and flower heads; larvae in crowns

Sources: Delémont Rpt. (1962–63); Rome Rpt. (1963)

Acalles sp.

Plant recs.: *Carduus pycnocephalus* (Sicily)

Remarks: None

Sources: L. Andres in litt. (1961)

Acalles diocletianus (Germar)

Plant recs.: *Carduus ?nigrescens*, *Silybum* (Europe)

Remarks: Occasional visitor

Sources: Zwölfer (1965a)

Apion spp.

Plant recs.: *Carduus pycnocephalus* (Sicily, Italy, France); *C. acanthoides* (Austria, Switzerland); *C. crispus* (Rhine Valley); *C. defloratus* (Switzerland); *Carduus* spp. (Sicily, Switzerland); *Cirsium* (Switzerland, France, Rhine Valley); *Cynara* (France); *Centaurea* (Europe)

Remarks: Adults attack crowns and stems, larvae burrow in pith and pupate in cortical layer of *C. pycnocephalus*; adults on, and larvae boring in, stems of *C. acanthoides*; adults in stems of *C. crispus*; larvae in stems of *C. defloratus*; adults on *Carduus* sp., *Cynara*, and *Centaurea*; adults on, and larvae boring in, stems of *Cirsium*; although often recorded as "numerous" or "abundant," damage attributed to these beetles is "little" or none

Sources: Rome Rpt. (1960); L. Andres in litt. (1961); Delémont Rpts. (1962–63, 1965); Goeden (1974)

Apion (Ceratapion) sp. nr. A. armatum Gerstaecker

Plant recs.: *Carduus pycnocephalus*, *C. tenuiflorus*, *C. nutans*, *Centaurea* (Italy)

Remarks: Most common weevil attacking *Carduus* crowns in Italy (up to 65 larvae found in single large crown); damage to host is negligible; same sp. or closely related sp. also feeds on pith of stems; these plant recs. are rearing recs.

Sources: Rome Rpt. (1963)

Apion (Ceratapion) alliariae Herbst

Plant recs.: *Carduus tenuiflorus*, *C. pycnocephalus* (France); *Centaurea* (Yugoslavia, Italy); *Onopordum* (Italy)

Remarks: Reared from *Centaurea* in Yugoslavia; other recs. here are of adults on foliage

Sources: Zwölfer (1965a); Albany Rpt. (1966)

Apion (Ceratapion) carduorum Kirby (and ssp. *galactitis* Wencker)

Plant recs.: *Carduus pycnocephalus*, *C. personatus*, *C. nutans*, ?*C. acanthoides*, *Cirsium* (Europe – see remarks); ssp. *galactitis* – *C. nutans*, *C. pycnocephalus*, *C. tenuiflorus* (France, Italy, or Sicily; reared); *Galactites*, *Cynara*

Remarks: Adults only reared from *Carduus nutans* (larvae also, but identity questioned), *C. pycnocephalus*, and *C. personatus* (all from Europe); larvae reared from *Cirsium* (Europe); adults from *Cirsium* (Switzerland, Germany); adults (France) and larvae (Europe, identity of both recs. questioned) from *Carduus acanthoides*; adults on foliage, larvae within stems

Sources: Delémont Rpt. (1963); Zwölfer (1965a); Albany Rpt. (1966)

Apion (Ceratapion) onopordi Kirby

Plant recs.: *Carduus nutans*, *C. acanthoides*, *C. crispus*, *C. pycnocephalus*, *Carduus* sp., *Cirsium*, *Centaurea*, *Onopordum*, *Silybum* (Europe – see remarks)

Remarks: Adults on foliage, larvae in stems (and crowns); larvae reared from *Carduus acanthoides* and *C. nutans* (Germany), *C. pycnocephalus* and *Carduus* sp. (France), *Onopordum* and *Silybum* (Italy), and *Cirsium* (identity not verified) and *Centaurea* (Europe); adults (only)

recorded from foliage of *Carduus crispus* (Europe) and *C. acanthoides* (France, ident. not verified); screening tests for *A. onopordi* vs. *Centaurea* at Delémont (1965)

Sources: Delémont Rpts. (1963, 1965); CIBC Ann. Rpt. (1965); Zwölfer (1965a); Albany Rpt. (1966); Goeden (1974)

Apion (Ceratapion) pisi F.

Plant recs.: *Carduus nutans* (Italy)

Remarks: One specimen "probably" reared from *C. nutans*

Sources: Albany Rpt. (1966)

Apion (Pseudapion) fulvirostre Gyllenhall

Plant recs.: *Carduus acanthoides* (Europe)

Remarks: Occasional visitor

Sources: Zwölfer (1965a)

Brachynotus sp.

Plant recs.: *Carduus pycnocephalus* (S. Europe)

Remarks: Rare; adults and larvae on leaves

Sources: Goeden (1974)

Ceutorhynchus sp.

Plant recs.: *Carduus edelbergii* (Pakistan)

Remarks: Adult feeding on *Carduus* in Pakistan, poss. only an occasional visitor; different from *Ceutorhynchus* spp. of Europe

Sources: A17-ENT-9 Rpts. (1963, 1965); Baloch et al. (1971)

Ceutorhynchus sp. nr. *C. litura* (F.)

Plant recs.: *Carduus acanthoides*, *C. nutans* (E. Austria)

Remarks: Eggs and larvae common in rosettes of *C. acanthoides*; poss. an ecotype of *Ceutorhynchus litura* preferring *Carduus* over *Cirsium*

Sources: Delémont Rpt. (1966)

Ceutorhynchus (Hadropontus) litura (F.)

Plant recs.: *Carduus defloratus*, *C. nutans*, *C. tenuiflorus*, *C. personatus*, *C. acanthoides*, *C. crispus*, *Cirsium*, *Silybum*, *Onopordum*, *Centaurea*, *Cynara*, *Cnicus*, *Aster*, *Carthamus*, *Echinops*, *Xeranthemum*, *Lactuca* (Europe and in lab. tests - see remarks)

Remarks: Adults feed on foliage; larvae endophytic in leaves, stems, root collars, and occasionally in roots; hosts limited to *Cirsium*, *Carduus*, and *Silybum*

Field recs.: Adults and larvae from *Carduus*

defloratus (Switzerland), *Cirsium* (Switzerland, Sweden, France, Germany), and *Carduus nutans* and *C. crispus* (France)

History: Screening tests at Delémont, 1961–66; shipments made to Canada, 1963–67; Working Group on Biological Control of Weeds approved release in Canada, 1965; small field cage study, 1965; first field release, 1967; insect studied and released to control Canada thistle (*Cirsium arvense*)

Results of lab. screening tests (D = Delémont, B = Belleville): Adults fed regularly on *Carduus defloratus* (D), *C. nutans* (D), *C. tenuiflorus* (D), *C. personatus* (D), *C. acanthoides* (B), *Cirsium* (D, B), *Silybum* (D, B), and occasionally ate *Onopordum* (D, B), *Centaurea* (D), *Cynara* (D, B), *Cnicus* (D), *Aster* (D), *Carthamus* (D), *Echinops* (D), *Lactuca* (D, B), and *Xeranthemum* (D); larvae fed and developed only on *Carduus defloratus* (D) and *Cirsium* (D), and fed but did not develop on *Silybum* (D); eggs deposited in *C. defloratus* (D) and *Cirsium* and *Silybum* (D) only

Releases in Canada on *Cirsium arvense*: 22 A in field cage study in Ont. in 1965; 270 A released in Ont. (2 locs.) in 1967; 70 A in Sask. in 1973; 100 A in Sask. in 1974; 69 A in B.C., 57A in Alta, and 41 A in Sask. in 1975; 56 A in Sask. in 1976; cleared for release on *Cirsium arvense* in U.S. by the Working Group on Biological Control of Weeds in 1969; 25 Canadian collected adults sent to SEA-AR lab., Albany, Calif., in 1970 (rearing attempt failed); adults (2,900+) collected on *Cirsium arvense* and *Carduus nutans* sent to Albany from Germany and Switzerland in 1971–75

Releases in U.S. on *Cirsium arvense*: 154 A in S. Dak. and 100 A in Idaho in 1972; 231 A in Idaho, 125 A in Mont., and 192 A in Calif. in 1973; 410 A in Calif., 200 A in Wash., 400 A in Idaho, and 150 A in Colo. in 1974; 280 A in Idaho and 150 A in Md. in 1975; rearing attempted in 1975 in N.J. by N.J. Dept. Agr.; larvae from Mont. released in Md. in 1978 and 1979

Recovery data: Recovered at 1967 Ont. release site in 1968 and spreading at one site in Ont. (established on *Cirsium*); established and increasing in Sask. by 1976; established in Mont.; some evidence of potential establishment in Idaho and Calif.; 1967 release population at Belleville, Ont., has caused decline of *C. arvense* shoots from 28.8 to 0.24/m² in density

Parasite: *C. litura* may disseminate the thistle rust *Puccinia punctiformis* (Str.) Kohl. in Ont.; the fly *Phaonia trimaculata* (Bouche) is a European enemy as is the protozoan *Nosema* sp.

Sources: Delémont Rpts. (1961-67); CIBC Ann. Rpts. (1963-67, 1974); Williamson (1963-65, 1966-70); Zwölfer (1964, 1965a); Zwölfer and Harris (1966); Canada Dept. Agr. Res. Inst., Belleville, Rpts. (1967-73); Albany Rpts. (1969-75); Zwölfer and Pattullo (1970); Peschken (1971); Peschken and Beecher (1973); P. H. Dunn in litt. (1978)

Ceutorhynchus (Hadropontus) trimaculatus (F.)

Plant recs.: *Carduus nutans*, *C. pycnocephalus*, *C. tenuiflorus*, *C. myriacanthus*, *Galactites*, *Cirsium* (Europe); *Carduus acanthoides*, *Cirsium*, *Cynara*, *Silybum*, *Onopordum*, others (in lab. tests - see remarks)

Remarks: Adults feed on foliage, oviposit on new growing tips; larvae bore into crown itself, feed gregariously

Field recs.: Adults and larvae from *Carduus nutans*, *C. pycnocephalus*, and *Galactites* (Italy), *C. pycnocephalus* (S. France, N. Spain), *Carduus myriacanthus* (Algeria), and *C. tenuiflorus* and *Cirsium* (Europe)

Tests for *Carduus* spp. at SEA-AR lab., Rome, 1968-73: In tests, adults fed on *Carduus pycnocephalus*, *C. nutans*, *C. acanthoides*, *Cirsium*, *Cynara*, *Galactites*, *Silybum*, *Onopordum*, *Echinops*, and nibbled other plants; oviposited on *Carduus* spp., *Cirsium*, *Cynara*, *Silybum*, and *Galactites*; larvae developed to adult on *Carduus nutans*, *C. acanthoides*, *Cirsium*, *Cynara*, *Onopordum*, and *Galactites*

Field tests to study biology and survival on *Cynara* begun at Rome, 1975: Adults (1,400+)

sent to SEA-AR lab., Albany, Calif., to test for potential release against *Carduus tenuiflorus*, *C. nutans*, and *C. pycnocephalus*, 1970-73; tests unsuccessful, few adults, no egg production; some adult feeding on *Carduus nutans*, *Cirsium* spp., and *Cynara*; in 1975, adults (900+) sent from Rome lab. to VPI for initiation of testing of *C. trimaculatus* at that lab.

Sources: Rome Rpts. (1964, 1966, 1968-70, 1975); Delémont Rpt. (1965); Zwölfer (1965a); K. E. Frick in litt. (1966, 1969); Zwölfer and Harris (1966); Albany Rpts. (1970-73); Goeden (1974); Goeden et al. (1974); Maw (1976)

Chlorophanus viridis (L.)

Plant recs.: *Cirsium* (Austria, Rhine Valley); *Carduus tenuiflorus*, *C. crispus*, *C. personatus*, *Aster*, *Chrysanthemum*, *Tussilago*, *Rudbeckia*, *Achillea*, *Senecio*, *Calendula*, *Echinops*, *Silybum*, *Centaurea*, *Taraxacum*, *Sonchus*, *Inula*, *Cnicus*, *Cynara* (in lab. tests only)

Remarks: In lab. tests (Delémont, 1963), sp. fed heavily or regularly on all these listed plants except last three, on which only nibbling occurred; polyphagous sp. of no biological control interest

Sources: Delémont Rpt. (1963); Zwölfer (1965a)

Cleonus piger Scopoli

Plant recs.: *Carduus nutans*, *C. acanthoides*, *C. pycnocephalus*, *C. defloratus*, *C. crispus*, *C. edelbergii*, *Cirsium*, *Arctium*, *Onopordum*, *Silybum*, *Centaurea*, *Cnicus*, *Rumex*, *Inula*, *Zinnia*, *Rudbeckia*, *Carthamus*, *Cynara*, *Taraxacum*, *Lactuca*, *Sonchus*, *Leontodon*, *Carlina*, *Cicer*, *Cannabis*, *Ziziphus*, *Tanacetum* (Europe, Asia, N. Amer., and in lab. tests - see remarks)

Remarks: A crown and root borer; adults feed on foliage; larvae bore into basal part of roots and also attack rosettes of blooming host plant; larvae inflict damage, causing stunting and premature dying; reported as an economic pest of *Cynara* in Italy, will feed on wide range of Compositae

Field hosts: *Carduus nutans* (Italy, Europe), *C. edelbergii* (Pakistan, Kashmir), *C. acanthoides*

(Europe), *Cirsium* (Pakistan, Switzerland, Italy, N. Amer.), *Cnicus* and *Rumex* (Pakistan; stage unknown), *Silybum* (Europe; adults only, Pakistan), and *Centaurea* (USSR – Caucasus); N. Amer. distrib.: N.Y. (since 1929), Pa. (1956), Mich. (1974), and Ont. and Que. on *Cirsium arvense* (1940, 1971)

Results of lab. tests (Delémont 1963, 1968): Adults fed heavily or regularly on *Carduus nutans*, *C. defloratus*, *C. crispus*, *Inula*, *Zinnia*, *Rudbeckia*, *Cnicus*, *Carthamus*, *Arctium*, *Cynara*, *Onopordum*, *Silybum*, *Cirsium*, *Centaurea*, *Taraxacum*, *Lactuca*, *Sonchus*, *Leontodon*, and occasionally on *Tanacetum*; found breeding on *Carduus nutans*, *Cirsium*, and *Carlina*

Sources: Mellini (1951a); Anderson (1956); A17-ENT-9 Rpts. (1960–62, 1965); Delémont Rpts. (1962–63, 1968); Rome Rpt. (1963); Zwölfer (1965a); Peschken (1971); Harris and Zwölfer (1971); Baloch et al. (1971); Goeden (1974); Maw (1976); D. Whitehead, pers. comm. (1977)

Conotrachelus sp.

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Rare; adults on leaves; polyphagous crop pest

Sources: Morihara and Balsbaugh (1976)

Donus crinitus (Boheman)

Plant recs.: *Carduus pycnocephalus* (S. Europe)

Remarks: Occasional larvae and adults eat leaves

Sources: Goeden (1974)

Hypera spp.

Plant recs.: *Carduus nutans* (Italy, Europe); *C. pycnocephalus* (Italy, S. Calif.)

Remarks: Occasional visitor on *C. nutans* in Europe, locally common; larvae and adults eat leaves in Calif.

Sources: L. Andres in litt. (1961); Zwölfer (1965a); Goeden (1974)

Hypera comata Boheman

Plant recs.: *Carduus nutans*, *Cirsium* (Switzerland); *Tussilago*, *Aconitum*, *Chaerophyllum* (literature); *Solidago*, *Erigeron*, *Aster*, *Zinnia*, *Achillea*, *Chrysanthemum*, *Tussilago*, *Calendula*, *Echinops*, *Arctium*, *Silybum*, *Cirsium*, *Lactuca* (in lab. tests)

- Remarks: Field rec. on *C. nutans* was of larvae; in lab. tests, species found to have wide host range and thus of no interest for biological control
- Sources: Delémont Rpt. (1962)
- Hypera postica* Gyllenhal (= *Phytonomus variabilis* Herbst)
- Plant recs.: *Carduus edelbergii*, *Cynoglossum*, *Medicago*, *Polygonum*, *Ziziphus* (Pakistan); *Cirsium* (Canada)
- Remarks: Larvae feeding on leaves of *C. nutans*; polyphagous; pest of alfalfa
- Sources: A17-ENT-9 Rpts. (1961, 1965); Baloch et al. (1971); Maw (1976)
- Larinus* spp.
- Plant recs.: *Carduus defloratus* (Europe); *C. crassifolius*, *C. acanthoides* (Austria); *C. pycnocephalus*, *C. nutans* (Italy); *C. chrysacanthus* (Yugoslavia)
- Remarks: Larvae (only) found in flower heads of first of these three listed plants; stage of insect found on last three of these recs. is unknown
- Sources: L. Andres in litt. (1961); Delémont Rpt. (1962); Zwölfer (1965a); Zwölfer et al. (1971)
- Larinus australis* Capimont
- Plant recs.: *Centaurea* (Austria, France, Switzerland, Yugoslavia, Italy, Spain, Hungary); *Carduus defloratus*, *C. nutans*, *C. tenuiflorus*, *C. personatus*, *Centaurea*, *Arctium*, *Cirsium*, *Silybum*, *Cynara*, *Onopordum*, *Carthamus*, *Cnicus*, *Lactuca* (in lab. tests)
- Remarks: In lab. tests, *L. australis* adults fed heavily on *Centaurea* and regularly on all plants listed here except *Lactuca* and 4 *Carduus* spp., on which only slight feeding occurred; listed as meriting further study for biological control of *Centaurea*
- Sources: Delémont Rpts. (1963–64); Rome Rpt. (1963); Zwölfer (1965a); Zwölfer et al. (1971)
- Larinus brevis* (Herbst) (= *L. sanctaebalmae* Alberville)
- Plant recs.: *Carlina* (Switzerland, Austria, Germany); *Atractylis* (France); *Carduus nutans*, *C. personatus*, *Carlina*, *Rudbeckia*, *Tussilago*, *Echinops*, *Cirsium*, *Cynara*, *Onopordum*, *Centaurea* (in lab. tests)
- Remarks: Adults feed on young leaves; larvae feed within receptacle, destroying ovaries and

seeds; species prefers *Carlina*; specimens from *Carlina vulgaris* differ from *C. acaulis* (ident. questioned)

In lab. tests: *L. brevis* adults fed heavily on *Carlina* or regularly on all these listed plants

Recorded parasites: *Exeristes roborator* (F.), *Tetrastichus* sp., and braconid sp.

Sources: Delémont Rpts. (1963-64); Zwölfer (1965a); Zwölfer et al. (1971)

Larinus carlinae Olivier (= *L. planus* Germar)

Plant recs.: *Carduus crispus*, *C. pycnocephalus*, *C. acanthoides*, *C. nutans*, *C. nigrescens*, *C. litigiosus*, *C. tenuiflorus*, *C. personatus*, *C. defloratus*, *Galactites*, *Cirsium*, *Centaurea*, *Carlina*, *Arctium*, *Cynara*, *Onopordum*, *Silybum*, *Zinnia*, *Erigeron*, *Helianthus*, *Echinops*, *Xeranthemum*, *Cnicus*, *Carthamus* (Europe and lab. recs. - see remarks)

Remarks: Adults feed on foliage, damage not particularly noticeable; larvae feed on flower buds, destroying ovarioles, etc.; feeding preference: Carduinae and some Centaureinae, indices high on *Silybum-Cirsium-Carduus*

Field recs.: Adults and larvae from *Carduus crispus* (Rhine Valley, Europe), *C. pycnocephalus* and *C. acanthoides* (Europe, France, Italy), *Galactites* (Europe), and *Cirsium* (France, Switzerland, Austria); adults (only) from *Carduus acanthoides*, *C. nutans*, *C. nigrescens*, *C. litigiosus*, and *Centaurea* (Europe); larvae from *Carduus tenuiflorus*, *Centaurea*, and *Carlina*; other distrib. S. Germany and Caucasus

Results of lab. tests (Delémont): Adults fed heavily or regularly on *Carduus nutans*, *C. tenuiflorus*, *C. crispus*, *C. personatus*, *Silybum*, *Cirsium*, *Centaurea*, *Arctium*, *Cynara*, *Onopordum*, *Zinnia*, and occasionally or irregularly on *Erigeron*, *Helianthus*, *Echinops*, *Xeranthemum*, *Cnicus*, *Carthamus*, and *Carduus defloratus*; successful oviposition obtained on *Cirsium* and *Carduus defloratus*; successful development of larvae observed on *Carduus crispus*, *C. defloratus*, and *Cirsium*; small number of adults shipped to Canada in 1962 and 1964 for testing

Recorded parasites: "Ephialtes sp." (France) and *Bracon* sp.

Sources: Delémont Rpts. (1961-64); L. Andres in litt. (1961); Rome Rpt. (1963); CIBC Ann. Rpt. (1964); Zwölfer (1965a); Zwölfer et al. (1971)

Larinus cynarae F.

Plant recs.: *Carduus pycnocephalus*, *C. nutans*, *Cirsium*, *Silybum*, *Onopordum*, *Cynara* (Europe)

Remarks: Adults and larvae oligophagous; in flowers

Sources: Zwölfer et al. (1971)

Larinus flavescens Germar

Plant recs.: *Carduus chrysacanthus* (Yugoslavia); *Silybum*, *Centaurea*, *Carthamus*, *Echinops*, other plants (S. Europe, N. Africa)

Remarks: Adults rec. in flower heads of *Carduus*; larvae in flower heads of other plants

Sources: F4-ENT-5 Rpt. (1969); Zwölfer et al. (1971); F4-ENT-16 Rpt. (1974)

Larinus jacea F.

Plant recs.: *Carduus acanthoides*, *C. nutans*, *C. personatus*, *C. pycnocephalus*, *C. tenuiflorus*, *C. crispus*, *C. defloratus*, *C. chrysacanthus*, *Cirsium*, *Galactites*, *Silybum*, *Cynara*, *Centaurea*, *Carthamus*, *Onopordum*, *Arctium*, *Carlina*, *Echinops*, *Chrysanthemum*, *Zinnia*, *Erigeron*, *Aster*, *Achillea*, *Xeranthemum* (Europe and lab. recs. - see remarks)

Remarks: Adults feed on host leaves and peduncles without causing visible damage; larvae (1-3) feed in capitulum; subtribe Carduinae preferred

Field recs.: Adults and larvae from *Carduus acanthoides* (France, Austria, Europe), *C. nutans* (Austria, Italy, Europe), *C. personatus* (France), *C. pycnocephalus*, *C. tenuiflorus* (Italy), and *Cirsium*, *Centaurea*, *Galactites* (Europe); adults (only) from *Cynara* (Italy, 1 "resting"); stage unknown from *Carduus chrysacanthus* (Yugoslavia); distrib. also in SW Asia to Turkestan; not observed in Rhine Valley or Swiss Valais

Results of lab. tests (Delémont): Adults fed heavily or regularly on *Carduus nutans*, *C. crispus*, *C. defloratus*, *C. tenuiflorus*, *C. personatus*, *Cirsium*, *Silybum*, *Cynara*, *Zinnia*, *Echinops*, *Chrysanthemum*, *Carlina*, *Arctium*,

Onopordum, *Centaurea*, *Carthamus*, and occasionally on *Erigeron*, *Aster*, *Achillea*, and *Xeranthemum*; successful larval development on *Carduus acanthoides*, *C. nutans*, and *C. personatus*

Recorded parasites: *Tetrastichus* sp., *Bracon urinator* F., and *Exeristes roborator* (F.)

Sources: Mellini (1951b); L. A. Andres in litt. (1961); Delémont Rpts. (1963-64); Rome Rpt. (1963); Zwölfer (1965a); Zwölfer et al. (1971)

Larinus scolymi Olivier

Plant recs.: *Carduus pycnocephalus* (Italy, France); *C. nutans* (Europe); *Cynara* (Italy, France, Europe); *Cirsium* (Europe); *Onopordum* (Europe); *Echinops* (Algeria)

Remarks: Recorded as pest of *Cynara* in Italy and S. France; all these other recs. are of adults only

Sources: L. A. Andres in litt. (1961); Rome Rpt. (1963); Delémont Rpt. (1964); Zwölfer (1965a); Zwölfer et al. (1971)

Larinus sturnus Schaller

Plant recs.: *Carduus acanthoides*, *C. nutans*, *C. crispus*, *C. nigrescens*, *C. personatus*, *C. defloratus*, *C. tenuiflorus*, *Cirsium*, *Centaurea*, *Arctium*, *Silybum*, *Cynara*, *Onopordum*, *Carthamus*, *Echinops*, *Rudbeckia*, *Erigeron*, *Zinnia*, *Xeranthemum*, *Cnicus*, *Aster*, *Carlina* (Europe and lab. tests - see remarks)

Remarks: Adults feed on foliage and peduncle; larvae mine receptacle destroying ovarioles

Field recs.: Adults and larvae from *Carduus nutans* (Swiss Alps, French Rhine Valley, Italy), *C. acanthoides* (centr. Europe), *C. nigrescens* (France), *C. personatus* (Europe), *Cirsium* (Swiss Alps, French Rhine Valley, Italy), *Centaurea* (French Rhine Valley, Italy), and *Arctium* (Austria); adults (only) from *Carduus crispus* (Switzerland); distrib. also E. Asia and N. Africa (from literature) and N. Yugoslavia (*Cynara* given as host in literature); Austrian population is only *Larinus* found in Europe to attack *Arctium*; adults from Austria prefer *Arctium* over *Carduus* or *Centaurea*; those bred from *Carduus* (from Rhine Valley) pre-

ferred *Carduus* to *Arctium* or *Centaurea*, and those from *Centaurea* (from Rhine Valley) preferred *Centaurea* over *Carduus* or *Arctium*

Results of lab. tests (Delémont): Adults (Rhine Valley *Carduus* population) fed heavily or regularly on *Carduus nutans* (also in lab. tests at SEA-AR lab. in Rome), *C. crispus*, *C. personatus*, *C. tenuiflorus*, *C. defloratus*, *Cirsium*, *Centaurea*, *Silybum*, *Cynara* (also at Rome), *Onopordum*, *Carthamus*, *Echinops*, *Arctium*, *Rudbeckia*, and occasionally on *Erigeron*, *Zinnia*, *Xeranthemum*, *Cnicus*, *Aster*, and *Carlina*; oviposition obtained on *Carduus defloratus*, *Cirsium*, *Centaurea*, and *Arctium* (by *Arctium* population only); larvae bred successfully from *Arctium* (Austrian population only), *Cirsium*, *Carduus nutans*, and *Centaurea*

Recorded parasites: *Bracon* sp. and chalcidoids; a possible biocontrol agent for *Centaurea* or *Carduus*

Sources: Delémont Rpts. (1962, 1964); Rome Rpt. (1963); Zwölfer (1965a); Zwölfer et al. (1971); CIBC Rpt. (1971)

Larinus turbinatus Gyllenhal

Plant recs.: *Carduus nutans*, *C. pycnocephalus*, *C. crispus*, *C. personatus*, *C. tenuiflorus*, *C. defloratus*, *Cirsium*, *Onopordum*, *Galactites*, *Centaurea*, *Serratula*, *Echinops*, *Cnicus*, *Arctium*, *Cynara*, *Silybum*, *Tanacetum*, *Zinnia*, *Xeranthemum*, *Carlina*, *Senecio*, *Leontodon* (Europe and/or in lab. tests – see remarks)

Remarks: Adults feed on leaves, stems, buds, and peduncles of hosts; larvae in flower heads seem restricted to *Cirsium*

Field recs.: Adults and larvae from *Cirsium* (Germany, France, Switzerland, Austria, Yugoslavia, Italy) and *Carduus nutans* and *Silybum* (France); larvae (only) from *Serratula* (Austria); adults (only) from *C. nutans* (Austria), *C. pycnocephalus* (France, Italy), *Onopordum* (Italy), *Galactites* (Italy), and *Galactites* and *Centaurea* (Europe)

Results of lab. tests (Delémont): Adults fed heavily or regularly on *Carduus nutans*, *C.*

crispus, *C. personatus*, *C. tenuiflorus*, *Cirsium*, *Echinops*, *Cnicus*, *Arctium*, *Cynara*, *Onopordum*, *Silybum*, *Centaurea*, *Tanacetum*, and occasionally (nibbled) on *Carduus defloratus*, *Leontodon*, *Senecio*, *Carlina*, *Xeranthemum*, and *Zinnia*; oviposition obtained only on *Cirsium*

Recorded parasites: *Bracon* sp. and chalcidoids; small shipments of *L. turbinatus* adults made to Canada in 1962 and 1965 for tests

Sources: H. L. Parker in litt. (1957); Delémont Rpts. (1961, 1964); Rome Rpt. (1963); CIBC Ann. Rpt. (1964); Zwölfer (1965a); Zwölfer et al. (1971)

Larinus ursus F.

Plant recs.: *Carduus nutans*, *Centaurea*, *Carlina* (S. Europe)

Remarks: Adults rec. on *Carduus* and *Centaurea*; larvae on *Carlina*; in flower heads

Sources: Zwölfer (1965a); Zwölfer et al. (1971)

Leptomias jekeli Faust

Plant recs.: *Carduus edelbergii*, *Cnicus*, *Dipsacus*, *Abies* (Pakistan)

Remarks: Adults feeding on leaves

Sources: A17-ENT-9 Rpt. (1965); Baloch et al. (1971)

Leptomias stolickzae Faust

Plant recs.: *Carduus edelbergii* (Pakistan)

Remarks: Adults feeding on leaves; no other hosts known

Sources: A17-ENT-9 Rpt. (1965); Baloch et al. (1971)

Lixus spp.

Plant recs.: *Carduus pycnocephalus*, *C. nutans* (Italy, France); *C. crispus* (Rhine Valley)

Remarks: Larvae in flower head of *C. crispus*

Sources: Rome Rpts. (1960-61); L. A. Andres in litt. (1961); Delémont Rpt. (1963)

Lixus algirus (L.)

Plant recs.: *Carduus nutans*, *C. litigiosus*, *C. acanthoides*, *C. pycnocephalus*, *C. defloratus*, *C. personatus*, *C. crispus*, *C. tenuiflorus*, *Cirsium*, *Onopordum*, *Galactites*, *Cnicus*, *Silybum*, *Malva*, *Althea*, *Vicia*, *Centaurea*, *Sonchus*, *Carthamus*, *Arctium*, *Cynara*, *Rudbeckia*, *Zinnia*, *Calendula*, *Xeranthemum*, *Chrysanthemum*, *Senecio*, *Echinops*, *Carlina* (Europe, Pakistan, and/or in lab. tests - see remarks)

Remarks: Adults feed on leaves and oviposit in stems of hosts; found to be rather polyphagous (see following remarks); a "potential pest" in Europe and a "known pest" in Pakistan

Field recs.: Ovipositing adults and larvae from *Cirsium* (Switzerland, France, Rhine Valley), *Carduus nutans* (Austria, Europe), and *C. litigiosus* (France); adults (only) from *Onopordum* and *Galactites* (France), *Carduus acanthoides*, *C. pycnocephalus*, and *Silybum* (Europe), and *Cnicus* (Pakistan); further literature recs. (adults only) from *Centaurea*, *Malva*, *Althea*, and *Vicia* (damage reported to flowers and foliage of vetch); larvae recorded from 'Malvaceae' in literature

Results of lab. tests (Delémont): Adults fed heavily or regularly on *Cirsium*, *Silybum*, *Carduus crispus*, *C. defloratus*, *C. nutans*, *C. personatus*, *Sonchus*, *Carthamus*, *Arctium*, *Cynara*, *Centaurea*, *Rudbeckia*, *Onopordum*, and occasionally on *Zinnia*, *Calendula*, *Xeranthemum*, *Cnicus*, *Chrysanthemum*, *Senecio*, *Echinops*, and *Carlina*; of no interest in biological control

Sources: Delémont Rpts. (1962, 1964); A17-ENT-9 Rpt. (1965); Zwölfer (1965a); Goeden (1974)

Lixus (Lixochelus) cardui Olivier

Plant recs.: *Onopordum* (Austria, Europe); *Carduus nutans* (Austria, Italy?); *C. pycnocephalus* (Europe, Italy?); *C. acanthoides*, *Cirsium* (Europe); *Silybum* (Syria); *Carduus defloratus*, *C. tenuiflorus*, *C. crispus*, *Arctium*, *Cynara*, *Silybum*, *Centaurea*, *Carlina* (in lab. tests only)

Remarks: Larvae found breeding in field only on *Onopordum*; other field recs. listed here are of adults only; Italian recs. are of *L.* "prob. *cardui*"

Results of lab. tests (Delémont): Adults fed heavily or regularly on *Onopordum*, *Cirsium*, *Carduus defloratus*, *C. nutans*, *C. tenuiflorus*, *C. crispus*, *Arctium*, *Cynara*, *Silybum*, *Centaurea*, and occasionally on *Carlina*

Sources: Delémont Rpt. (1963); Rome Rpt. (1963); Zwölfer (1965a); F4-ENT-16 Rpt. (1976)

COLEOPTERA—Continued

Curculionidae—Continued

Lixus sp. nr. *L. elongatus* Goeze (or *L. rufitarsis* Boheman)

Plant recs.: *Carduus pycnocephalus* (Lebanon, Syria); *C. tenuiflorus*, *C. pycnocephalus*, *C. nutans*, *C. litigiosus*, *C. defloratus*, *Galactites*, *Cirsium*, *Silybum*, *Cynara*, *Onopordum*, *Xeranthemum*, *Helianthus* (Europe and/or in lab. tests – see remarks)

Remarks: Field recs.: Ovipositing adults from *Carduus tenuiflorus*, *C. pycnocephalus*, and *C. litigiosus* (France); larvae observed breeding only on *C. tenuiflorus*; adults (France) and larvae (Rhine Valley) from *Cirsium*; adults from *Carduus nutans* and *Galictites* (Europe)

Results of lab. tests (Delémont): Adults fed heavily or regularly on *Carduus tenuiflorus*, *C. nutans*, *Cirsium*, *Silybum*, *Onopordum*, *Cynara*, and *Xeranthemum*; in early tests, also fed on *Carduus defloratus* and *Helianthus*; 130 adults sent to Canada in 1964

Sources: Delémont Rpts. (1962–64); CIBC Ann. Rpt. (1964); Zwölfer (1965a); F4-ENT-16 Rpt. (1974)

Lixus (Lixochelus) elongatus Goeze

Plant recs.: *Carduus nutans*, *C. acanthoides*, *C. crispus*, *C. pycnocephalus*, *C. ?nigrescens*, *C. defloratus*, *C. tenuiflorus*, *C. personatus*, *Cirsium*, *Silybum*, *Onopordum*, *Centaurea*, *Cynara*, *Arctium*, *Carlina*, *Xeranthemum*, *Erigeron* (Europe and/or in lab. tests – see remarks)

Remarks: Adults feed on foliage, often skeletonizing host; larvae feed in root collars and in lower parts of stem; feeding restricted enough to warrant further testing for biological control of *Carduus* spp. or *Cirsium vulgare* (not *C. arvense*)

Field recs.: Adults and larvae from *Carduus acanthoides* (France, Europe), *C. nutans* (Italy, Austria, Rhine Valley, Europe), *C. crispus* (Europe), and *Cirsium* (Rhine Valley, Switzerland, Austria, France); adults (only) from *Carduus pycnocephalus* (Italy) and *C. nigrescens*, *Silybum*, and *Onopordum* (Europe)

Results of lab. tests (Delémont): Adults fed heavily or regularly on *Cirsium*, *Silybum*, *Car-*

duus crispus, *C. personatus*, *C. tenuiflorus*, *C. nutans*, *C. defloratus*, *Centaurea*, and occasionally on *Xeranthemum*, *Carlina*, *Arctium*, *Cynara*, *Onopordum*, and *Erigeron*; oviposition obtained only on *Carduus* and *Cirsium*; shipment of 110–120 adults made to Canada in 1963; judged unsuitable for biological control of *Cirsium arvense* in Canada, larvae do not survive on this species

Sources: Mellini (1951a); L. A. Andres in litt. (1961); Delémont Rpts. (1962–63); Belleville Res. Inst. Rpt. (1962–63); CIBC Ann. Rpt. (1963); Rome Rpt. (1963); Zwölfer (1965a); Goeden (1974)

Lixus junci Boheman

Plant recs.: *Carduus nutans*, *Cirsium* (Europe)

Remarks: Occasional visitor on *C. nutans*

Sources: Zwölfer (1965a)

Lixus sp. prob. *L. scolopax* Boheman

Plant recs.: *Carduus pycnocephalus*, *C. nutans*, *Silybum*, *Cynara* (Italy)

Remarks: Adult feeding and oviposition observed on *C. nutans* only

Sources: Rome Rpt. (1963); Goeden (1974)

Lixus spartii Olivier

Plant recs.: *Carduus crispus* (Europe)

Remarks: Occasional visitor

Sources: Zwölfer (1965a)

Otiorhynchus sp.

Plant recs.: *Carduus personatus* (Europe)

Remarks: Occasional visitor

Sources: Zwölfer (1965a)

Pseudocleonus grammicus Panzer

Plant recs.: *Centaurea* (Yugoslavia, France); *Carlina* (Europe); *Carduus personatus*, *Cirsium*, *Silybum*, *Onopordum*, *Arctium*, *Carthamus*, *Echinops*, *Tanacetum*, *Chrysanthemum*, *Inula* (in lab. tests only)

Remarks: Field recs. on *Centaurea* are of larvae found in the roots; recs. on *Carlina* are of adults on foliage

Results of lab. tests (Delémont) for *Cirsium*: Adults (from *Carlina*) fed regularly on *Carduus personatus* (but not on 3 other spp. of *Carduus*), *Centaurea*, *Cirsium*, *Silybum*, *Onopordum*, *Arc-*

tium, *Carthamus*, *Carlina*, *Echinops*, *Tanacetum*, *Inula*, and *Chrysanthemum*

Sources: Delémont Rpts. (1963, 1965); CIBC Ann. Rpts. (1963, 1965); Zwölfer (1965a)

Rhinocyllus conicus (Froelich)

Plant recs.: *Carduus nutans*, *C. acanthoides*, *C. personatus*, *C. pycnocephalus*, *C. nigrescens*, *C. crispus*, *C. litigiosus*, *C. tenuiflorus*, *Cirsium*, *Silybum*, *Onopordum*, *Centaurea*, *Cnicus*, *Galactites*, *Xeranthemum*, *Carlina*, *Tagetes*, *Carthamus*, *Helianthus*, *Cichorium*, *Cynara*, *Lactuca*, rye, mangel, apple, radish (Europe and/or in lab. tests – see remarks)

Remarks: Adults gnaw peripheral tissue of stems, peduncles, and leaves; feeding is usually of little importance, less pronounced than that of *Larinus* spp.; eggs laid externally on flower bud; larvae (1-16 per flower (200 larvae per flower in Mont.)) mine receptacle, 3-4 larvae prevent seed formation; host range *Carduus-Cirsium-Silybum* (occasionally *Onopordum*) is believed to be highly stable, i.e., no tendency of *R. conicus* to form “races” attacking other plants

Field recs.: Adults and larvae from *Carduus nutans* (Switzerland, Austria, Italy, Europe), rarely *C. acanthoides* (France), *C. personatus* (Austria, Switzerland), *C. pycnocephalus* (France, Spain, Italy), *C. nigrescens* (France), *C. crispus* (Switzerland, France), mainly in large flowered species of *Carduus* and *Cirsium* (France, Switzerland, Germany, Austria), *Silybum* (France, Italy), *Onopordum* (France), and *Galactites*; adults (only) from *Carduus litigiosus* (France), *Xeranthemum*, *Centaurea*, *Cnicus*, and *Carlina* (Europe)

Other distrib.: N. Africa, S. England, E. Europe (Hungary, Poland, Czechoslovakia, Romania), and USSR (Ukraine, Caucasus, Kazakhstan, Altai)

Recorded European parasites: *Tetrastichus* sp., *Bracon urinator* F., *Aritranis* (= *Holocryptus*) *nigripes* (Gravenhorst), and an egg parasite

Results of lab. screening tests (all tests at

Delémont except a few at Belleville (B)): Adults fed heavily or regularly on *Carduus nutans*, *C. crispus*, *C. personatus*, *C. acanthoides* (also B), *Cirsium* (also B), *Silybum*, *Centaurea*, and *C. tenuiflorus* (last 3 in 1 test only, "occasionally" in 2d test), and occasionally *Tagetes*, *Xeranthemum*, *Onopordum*, *Carthamus*, *Cnicus*, *Helianthus*, *Cichorium*, *Cynara*, *Lactuca*, and (at B only) rye, mangel, apple, and radish; normal (4.5 eggs per female) oviposition obtained only on *Carduus nutans*, *C. personatus*, and *Cirsium*; atypical oviposition occasionally (0.3 egg per female) obtained on other (unpalatable) test plants (*Carthamus*, *Helianthus*, *Cnicus*, and *Cynara*); successful larval development only in *Cirsium*, *Carduus nutans*, and *C. personatus* (successful larval transference only into last one); in lab., prefers *Silybum* to *Cirsium* for oviposition (Albany Rpt., 1970)

History: First studied in 1962 by CIBC lab., Delémont; tested at Delémont and Belleville, 1962-68; U.S. Working Group on Biological Control of Weeds approved release in Canada, July 1968, and in U.S., Feb. 1969; adults collected and shipped by CIBC, Delémont, to Canada in 1964 (390), 1967-68 (2,500+), 1969-70 (many thousand), and to VPI, Blacksburg, Va., and SEA-AR lab., Albany, Calif., in 1969-73 (several thousand); adults also collected and shipped by SEA-AR lab., Rome, Italy, to Albany in 1969, 1971-75 (many thousand) and to VPI in 1971 (1,400)

Releases: First released by Canada Agr. on *Carduus nutans* in Sask. (400) and *C. acanthoides* in Ont. (370) in 1968; additional Canadian releases on *C. nutans* in Sask. (3,795) and in Ont. at 3 sites (4,952) in 1969; on *C. acanthoides* in Ont. at 3 sites (5,275) and *C. nutans* in Ont. at 2 sites (450) and on both spp. in Ont. (700) in 1970; released on *C. nutans* in Ont. (10,100), Sask. (120), and Man. at 2 sites (4,500) in 1974; and in Ont. at 2 sites (2,185) in 1975 (it was also released in New Zealand in 1975)

First released in U.S. by VPI on *C. nutans*, *C. thoermeri*, and *C. acanthoides* in Va. at 14 sites (2,000) and by SEA-AR, Albany, on *C. nutans* in Nebr. (60), Mo., Calif. (12), and Mont. (1,805) in 1969; addit. U.S. releases on *C. nutans*, *C. thoermeri*, and *C. acanthoides* in Va. at 9 sites (5,950) in 1970; on *Silybum marianum* in Calif. (1,141) and on *C. nutans* in Mont. (667) in 1971; on *S. marianum* in Calif. at 5 sites (2,062) and on *C. nutans* in Nebr. at 2 sites (663), Mont. (492), and Idaho (800) in 1972; on *C. nutans* in Nebr. at 2 sites (750), S. Dak. (1,000), Kans. (725), and Mont. (425); on *S. marianum* in Calif. at 4 sites (1,143) in 1973; on *C. nutans* in Calif. (440), Nebr. (440), Idaho (440), Colo. (440), and Nev.; on *S. marianum* in Calif. (370) in 1974; and on *C. pycnocephalus* in Calif. at 6 sites (3,069) in 1975

Recoveries and establishments: Well established in Sask. by 1974, seed production reduced by 63 percent at 1969 site, and recolonization begun in 1974; by 1976, 85 percent of seeds destroyed at 1 site in Sask.; also reported established in Ont.; in Va., *R. conicus* is well established at several sites on *Carduus nutans* and *C. thoermeri*, but it is less effective against *C. acanthoides*; at 1 Va. site, *C. nutans* was reduced by 95 percent 6 yrs. after initial release of 100 adults; dispersal was 1.6 km each year and 32 km 6 yrs. after release recolonization begun in 1972; at a 1971 *Silybum* release site in Calif., 67 percent of flower heads were infested by 1972, later increasing to 94 percent in 1973; it became established at 5 of 10 release sites in S. Calif. (Goeden and Ricker, 1977); it also attacks *C. pycnocephalus* in Calif.; in Mont., beetles at 5 1969-73 release sites had spread over an area of 1,280 km² by 1974, attacking *C. nutans* and *Cirsium arvense*; established in Colo. in 1976

Recolonizations: Over 20,000 adults collected from Va. establishments for recolonization in Va., W. Va., and Tenn. in 1972; reported established, infesting 70-80 percent of flower heads of *Carduus crispus* 3 yrs. after release in

W. Va.; further recolonization on *C. crispus* and *C. nutans* in W. Va. made in 1975; 20,000 adults collected annually in 1973-75 for redistribution against *C. nutans* and *C. acanthoides* in Va.; additional beetles collected in Va. for release in Md. (757), N.J. (600), and Pa. (70) against *C. nutans* and *C. thoermeri* in 1975, and Md. (416) against *C. nutans* and Pa. (297) against *C. nutans*, *C. thoermeri*, and *C. acanthoides* in 1976; established in Md. and Pa. in 1978. In Canada, collections for recolonization were made in Sask., Que. (10,100), and Man. (4,500) in 1974; establishments reported in both Que. and Man. in 1975; in Calif., beetles were collected at *Silybum* establishments for recolonization on *S. marianum* at new Calif. sites in 1974 (2,016 at 4 sites) and 1975 (365); in 1975, collections were made at establishments in Mont. for release on *C. nutans* in Calif. (500), Colo. (500), Idaho (1,000), Iowa (500), Minn. (500), N. Dak. (500), S. Dak. (500), Utah (1,000), Wash. (500), and Wyo. (500); collections also made in Va. in 1975 for releases in Kans. (375), Ky. (430), La. (350), Mo. (500 established and spread 2 mi by 1976), Okla. (388 established in 1977), and Tenn. (500).

Mortality factors: In Va., larval and egg mortality of 68 percent was caused by weather, crowding, and parasitism by *Aliolis curculionis* (Fitch), *Bracon mellitor* Say, and a parasite of Lepidoptera, *Campoplex polychrisidis* Viereck; in Calif., *R. conicus* was destroyed by *Hippodamia* sp., *Raphidia adnixa* Hagan, spiders, pyemotid mites, rodents, and cattle grazing thistles (Goeden and Ricker, 1977).

Sources: Mellini (1951b); Delémont Rpts. (1962-64, 1966-69, 1971); Zwölfer (1963, 1965a, 1967); Rome Rpts. (1963, 1969, 1971-75); CIBC Ann. Rpts. (1964, 1966-70); Williamson (1966-73); H. Zwölfer in litt. (1967); Albany Rpts. (1969-75); Zwölfer and Pattullo (1970); Harris and Zwölfer (1971); R. D. Hendrick in litt. (1971); Hawkes et al. (1972); Andres and Davis (1973); Canada Agr. Res. Branch Rpt. (1974); Goeden (1974); Goeden and Ricker (1974); Surles et al. (1974);

Kok (1974, 1975b); P. Harris in litt. (1975); Kok and Surles (1975); Surles and Kok (1975, 1976, 1977); Surles (1975); Surles et al. (1975); Hacker (1975); Batra in litt. (1975-76); Surles (1975); M. G. Maw in litt. (1976); Letendre et al. (1976); Hodgson and Rees (1976)

Rhodobaenus tredecimpunctatus (Illiger)

Plant recs.: *Carduus* sp. (Va.)

Remarks: Feeding

Sources: L. T. Kok in litt. (1976)

Sitona callosus Gyllenhal

Plant recs.: *Carduus edelbergii*, *Cnicus* (Pakistan); alfalfa (USSR)

Remarks: Adults feeding on leaves; "a known pest"

Sources: Alimdzhanov (1941); A17-ENT-9 Rpt. (1965); Baloch et al. (1971)

Tanymecus palliatus F.

Plant recs.: *Carduus acanthoides* (Austria); *Cirsium* (France, Austria, Europe); *Vitis*, *Chrysanthemum* (also in lab. test); *Beta*, cereals (in literature); *Solidago*, *Erigeron*, *Aster*, *Helianthus*, *Zinnia*, *Achillea*, *Tussilago*, *Calendula*, *Xeranthemum*, *Carthamus*, *Arctium*, *Cynara*, *Onopordum*, *Silybum*, *Centaura*, *Taraxacum*, *Lactuca* (all in lab. tests only)

Remarks: These field recs. are of adults only; adults feed on foliage; occasionally found listed in literature as pest of *Vitis*, *Chrysanthemum*, *Beta*, and cereals

In lab. tests (Delémont): Adults fed on all these plants except *Carduus* (*Vitis*, *Beta*, and cereals not incl. in tests); of no interest in biological control; broad feeding range

Sources: Delémont Rpts. (1962-63); Zwölfer (1965b)

Trichosirocalus horridus (Panzer) (= *Ceuthorrhynchidius horridus* (Panzer))

Plant recs.: *Carduus nutans*, *C. pycnocephalus* (Italy); *C. tenuiflorus*, *C. nutans*, *C. acanthoides*, *C. crispus* (Europe); *Galactites*, *Cirsium* (Italy); *Onopordum* (Europe); *Cynara*, other plants (lab. tests only)

Remarks: Adults in lab. feed at base of leaves, ovipositing on tips of new growth; larvae mine and bore to base of growing leaves, then feed

on crowns (12–18 larvae per crown not uncommon); reared from *Carduus nutans*, *C. pycnocephalus*, *Galactites*, and *Cirsium*; adults and larvae found on *Carduus acanthoides* and *Onopordum*; adults rare on new stands of *C. nutans* in Europe

Screening tests conducted at Delémont, 1964, and Rome (preliminary, 1964): *Hexameris brevis* (nematode) reared from *C. horridus* larvae from crowns of *Carduus nutans* (Italy)

Culture and studies conducted at Rome lab., 1968–70: Adults fed on *Carduus nutans*, *C. acanthoides*, *Cirsium*, *Galactites*, *Cynara*, and other plants; oviposited on these plants, *Carduus pycnocephalus*, and other plants

Adults (6,800+) collected in Italy and sent for final testing in quarantine at VPI, 1970–75; host-specificity tests at VPI: 1st instar larvae tested on 35 plant species; larvae were able to complete development in *Carduus nutans*, *C. acanthoides*, and *Cirsium vulgare*, not in *Cynara* and *Carthamus*; adults and larvae fed on these and other plants to lesser degree (Ward et al., 1974; Kok, 1975a); biology studies (Kok et al., 1975); European distrib. (Zwölfer and Harris, 1966); U.S. Working Group on Biological Control approved release in U.S. in 1974; released in Va. in 1975, established by 1978 (L. T. Kok, pers. comm., 1976, 1979); adults (490+) sent to Canada by CIBC-Delémont in 1975; released in Sask. (87 in 2 sites) in 1975; bred successfully (Harris, 1975); testing begun at SEA-AR lab., Albany, Calif., in 1974–78, confirmed safety to *Cynara* (release in Kans., N. Dak., S. Dak., Mo., Wyo., Nebr., Mont. planned for 1978–79)

Sources: Rome Rpts. (1964–66, 1968–73); Zwölfer (1965a); K. E. Frick in litt. (1966); Zwölfer and Harris (1966); Frick (1969); Ward et al. (1974); Kok (1975a); Kok et al. (1975); Harris (1975); CIBC Ann. Rpt. (1975); L. T. Kok, pers. comm. (1976)

COLEOPTERA—Continued

Buprestidae

Unidentified buprestid sp.

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Rare; endophagous larva

Sources: Morihara and Balsbaugh (1976)

Tenebrionidae

Unident. tenebrionid sp.

Plant recs.: *Carduus pycnocephalus* (S. Calif.)

Remarks: Rare; adults feeding on leaves

Sources: Goeden (1974)

Lathridiidae

Macrophthalmus sp.Plant recs.: *Carduus pycnocephalus* (S. Europe)Remarks: Rare; adults endophagous in flowers;
oligophagous

Sources: Goeden (1974)

LEPIDOPTERA

Unident. microlepidoptera

Plant recs.: *Carduus crassifolius* (Austria)Remarks: Larvae found in 0.7 percent of flower heads in
area

Sources: Delémont Rpt. (1963)

Arctiidae

Unident. arctiid sp.

Plant recs.: *Carduus pycnocephalus* (S. Europe)

Remarks: Rare; larvae on leaves

Sources: Goeden (1974)

Estigmene acrea (Drury)Plant recs.: *Carduus pycnocephalus* (Calif.)

Remarks: Rare; larvae on leaves; economic pest

Sources: Goeden (1974)

Nymphalidae

Cynthia cardui (L.) (= *Vanessa cardui*)Plant recs.: *Carduus edelbergii* (Pakistan); *C. nutans*
(Austria, Canada); *C. acanthoides* (France); *C. pycnocephalus*
(Egypt, Calif.); *C. pycnocephalus* and/or *C. tenuiflorus* (Calif.); *Carduus* spp. (U.S.,
Canada); *Cynara* (Italy); *Centaurea* (Pakistan,
Egypt); *Carthamus*, *Cnicus*, *Astragalus*, *Silybum*,
Urtica (Pakistan); *Cirsium* (Switzerland, France,
Canada); *Onopordum* (France, Austria); *Carlina*
(Europe); many other hosts

Remarks: Larvae feed externally on foliage; polyphagous; a pest of *Cynara* in France; pest of sunflower, soybean, and other crops; recorded parasites: *Apanteles* spp. (Pakistan, Switzerland)

Sources: Huffaker (1956); A17-ENT-9 Rpts. (1961, 1965); Delémont Rpts. (1962-63); CIBC Spec. Rpt. (1962); Rome Rpt. (1963); Albany Rpt. (1963); Zwölfer (1965a); F4-ENT-5 Rpts. (1966-67); Harris and Zwölfer (1971); Baloch et al. (1971); Goeden (1974); L. T. Kok in litt. (1976); Maw (1976); Morihara and Balsbaugh (1976)

Noctuidae

Unident. noctuid sp.

Plant recs.: *Carduus pycnocephalus* (S. Europe)

Remarks: Rare; larvae ectophagous on leaves

Sources: Goeden (1974)

Autographa gamma (L.) (= *Phytometra gamma*)

Plant recs.: *Carduus pycnocephalus*, *Centaurea* (Egypt, S. Europe)

Remarks: Rare; larvae on leaves; polyphagous crop pest

Sources: F-4-ENT-5 Rpts. (1966-67, 1969); Goeden (1974)

Eublemma parva (Hübner) (= *Porphyria parva*)

Plant recs.: *Carduus edelbergii* (Pakistan); *Xanthium* (Bangladesh, Pakistan); *Carthamus*, *Blumea*, *Inula* (Pakistan); *Centaurea* (Pakistan, Egypt); *Ziziphus* (China); *Tagetes*, *Conyza* (in lab. tests only)

Remarks: Larvae bore into burs of *Xanthium*, feed on seeds, flowers, and tender shoots; larvae feeding in flowers and fruits of *C. edelbergii*; larvae infesting drying heads of *Centaurea* in Egypt; in 1960, 12 shipments (3,285 larvae) of *E. parva* sent from CIBC Pakistan lab. to Queensland, Australia, as breeding stock for release vs. *Xanthium*; *E. parva* found to damage *Carthamus* in Pakistan (1961-62); *E. parva* found to be previously established in Australia

Results of lab. tests (Rawalpindi): Larvae fed to pupation on *Tagetes*, *Conyza*, and *Carthamus*; oviposition obtained on *Carthamus*

Recorded parasites (Pakistan): *Brachymeria* sp. nr. *aegyptiaca* Masi, *Apanteles* sp. nr. *stanton*

(Ashmead), *Eurytoma* sp., *Netelia* sp., and *Paraholaspis* sp.

Sources: CIBC Ann. Rpts. (1959-62, 1966-67); A17-ENT-9 Rpts. (1960-65); Ghani (1963); Tsao and Wang (1965); A17-ENT-14 Rpts. (1966-67); F4-ENT-5 and F4-ENT-16 Rpts. (1966-67, 1974); Baloch et al. (1968, 1971)

Eublemma purpurina (Denis and Schiffermüller) (= *Thalpochares purpurina*)

Plant recs.: *Carduus nutans* (Italy); *Cynara* (lab.); *Cirsium* (Europe)

Remarks: Larvae in petioles, crown, and buds

Sources: Mellini (1951a); Zwölfer (1965a); Rome Rpt. (1975)

Euxoa spp. (= *Agrotis* spp.)

Plant recs.: *Carduus pycnocephalus* (Egypt, Calif.); *Carduus* sp. (Va.)

Remarks: Common feeder on foliage; larvae on leaves in Calif. "prob. *E. tessellata* (Harris)"

Sources: F4-ENT-5 Rpts. (1967, 1969); Goeden (1974); L. T. Kok in litt. (1976)

Euxoa segetum Schiffermüller

Plant recs.: *Carduus edelbergii* (Pakistan)

Remarks: Larvae feeding in flowers; exophytic on stems and leaves; polyphagous crop pest

Sources: A17-ENT-9 Rpt. (1965); Baloch et al. (1971)

Heliothis armigera (Hübner)

Plant recs.: *Carduus edelbergii*, *Xanthium*, *Carthamus*, *Datura*, *Chrozophora*, *Loranthus*, *Trichodesma*, *Hypericum* (Pakistan); many others

Remarks: Larvae destroy flowers of *Carduus nutans* and *Carthamus*; feed on fruits of *Xanthium* and on leaves of *Loranthus*; polyphagous; an economic pest

Sources: CIBC Ann. Rpts. (1959, 1961); A17-ENT-9 Rpts. (1960-61, 1964-65); Baloch et al. (1968, 1971)

Lycanades purpurea (Grote)

Plant recs.: *Carduus pycnocephalus* (Calif.)

Remarks: Larvae occasionally feeding on leaves

Sources: Goeden (1974)

Papaipema arctivorans Hampson

Plant recs.: *Carduus* sp. (Va.)

Remarks: Common feeder

Sources: L. T. Kok in litt. (1976)

Papaipema nebris (Guenée)

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Larvae in stems; polyphagous crop pest

Sources: Morihara and Balsbaugh (1976)

Peridroma saucia (Hübner)

Plant recs.: *Carduus pycnocephalus* (Calif.)

Remarks: Larvae found rarely feeding on leaves;
economic sp.

Sources: Goeden (1974)

Geometridae

Unident. geometrid spp.

Plant recs.: *Carduus acanthoides* (Austria); *C. defloratus* (Switzerland); *C. pycnocephalus* (S. Europe); *C. nutans* (S. Dak.)

Remarks: Larvae in flower heads; on leaves

Sources: Delémont Rpts. (1962–63); Goeden (1974);
Morihara and Balsbaugh (1976)

Eupithecia sp.

Plant recs.: *Carduus* sp. (Va.)

Remarks: Common feeder

Sources: L. T. Kok in litt. (1976)

Pyralidae

Unident. phycitine sp.

Plant recs.: *Carduus personatus* (centr. Europe)

Remarks: Larvae endophytic in flower heads

Sources: Zwölfer (1965a)

Unident. pyralid spp.

Plant recs.: *Carduus pycnocephalus* and/or *C. tenuiflorus* (S. Europe, Calif.)

Remarks: Larvae boring into stems at leaf axils in Calif.; locally common in Europe; ectophagous on leaves; another sp. "probably *Myclopsis* sp." endophagous in flowers of *C. pycnocephalus* in Calif.

Sources: Albany Rpt. (1963); Goeden (1974)

Homoeosoma sp. (= *Phycitodes* sp.)

Plant recs.: *Carduus acanthoides* (France); *C. nutans* (Switzerland)

Remarks: Larvae attacking flower heads

Sources: Delémont Rpt. (1963); CIBC Ann Rpt. (1971)

Homoeosoma binaevella (Hübner) (= *Phycitodes binaevella*)

Plant recs.: *Carduus nutans* (Europe); *C. edelbergii* (Pakistan); *C. acanthoides*, *C. personatus* (Europe);

Cnicus, Echinops (Pakistan); *Cirsium* (France, Europe); *Centaurea, Anthemis, Senecio* (Europe)

- Remarks: Larvae endophytic in capitula; 3 generations per year; low incidence of attack generally in lab.; fed on *Carduus* and *Cirsium* spp. only, and not the 5 other Compositae tested; considered of possible use in control of *Carduus nutans*
- Sources: A17-ENT-9 Rpts. (1962-65); Rawalpindi Rpts. (1962, 1966, 1968); Delémont Rpt. (1963); Zwölfer (1965a); A17-ENT-14 Rpts. (1966, 1968); CIBC Ann. Rpt. (1970); Baloch et al. (1971)

Homoeosoma electellum (Hulst)

Plant recs.: *Carduus nutans* (Sask., S. Dak.)

Remarks: Larvae in flowers; pest of sunflowers

Sources: M. G. Maw in litt. (1976); Morihara and Balsbaugh (1976)

Homoeosoma nebulellum (Denis and Schiffermüller)

Plant recs.: *Carduus acanthoides* (Austria); *C. crispus* (Rhine Valley); *C. nutans* (Europe); *Cirsium, Silybum, Centaurea* (Europe)

Remarks: Larvae endophytic in flower heads

Sources: Delémont Rpt. (1963); Zwölfer (1965a)

Myelois sp.

Plant recs.: *Carduus nutans* (Rhine Valley)

Remarks: Larvae in flower heads

Sources: Delémont Rpt. (1963)

Myelois cibrumella Hübner (= *M. "cibrella"*)

Plant recs.: *Carduus nutans* (Rhine Valley, Europe); *C. acanthoides* (Europe); *Cirsium* (Germany, France, England, Switzerland, Austria); *Onopordum* (Austria); *Centaurea, Arctium, Carthamus* (Europe); *Jurinea, Echium* (literature); *Aster, Helianthus, Senecio, Silybum, Chrysanthemum* (in lab. oviposition tests only)

Remarks: Larvae endophytic in stems; also in flower heads of *Cirsium*

Results of lab. tests (Delémont, for *Cirsium*): Oviposition obtained on *Aster, Helianthus, Chrysanthemum, Senecio, Silybum, Centaurea, Arctium*, and especially on *Onopordum* and *Cirsium* (no *Carduus* incl. in tests); found to have a wide host range, dropped from further consideration in biological control

Sources: Mellini (1951a); Delémont Rpts. (1962-63); Zwölfer; (1965a)

Noctuelia floralis (Hübner)

Plant recs.: *Carduus pycnocephalus* (Egypt)

Remarks: Rare

Sources: F4-ENT-5 Rpt. (1967)

Ostrinia kasmirica (Moore)

Plant recs.: *Carduus edelbergii, Cnicus* (Pakistan)

Remarks: In stems

Sources: Baloch et al. (1971)

Ostrinia nubilalis (Hübner) (= *Pyrausta nubilalis*)

Plant recs.: *Carduus edelbergii* (Pakistan) occasionally *Cnicus* (Pakistan)

Remarks: Larvae in stems; this "strain" (of *O. nubilalis* from *Carduus nutans*) was not observed on corn; *Ephialtes* sp. and *Chlorocytus* sp. parasites of *O. nubilalis* on *Cnicus*; this sp. is a common crop pest

Sources: A17-ENT-9 Rpts. (1960-63, 1965); Baloch et al. (1971)

Phycita sp.

Plant recs.: *Carduus edelbergii* (Pakistan)

Remarks: Larvae feeding on leaves

Sources: A17-ENT-9 Rpt. (1965); Baloch et al. (1971)

Pyrausta silhetalis Guenée

Plant recs.: *Carduus edelbergii* (Pakistan)

Remarks: Larvae bore in stems; no other hosts known

Sources: A17-ENT-9 Rpt. (1965); Baloch et al. (1971)

Olethreutidae (= Eucosmidae)

?*Epiblemma* sp.

Plant recs.: *Carduus pycnocephalus* (Europe)

Remarks: Larvae endophagous in stems

Sources: Goeden (1974)

Epiblemma sp. nr. *E. scutulana* (Denis and Schiffermüller)

Plant recs.: *Carduus nutans, Cirsium* (Italy)

Remarks: Larvae mine stems and flower heads; damage to capitula of *C. nutans* reported to be severe

Sources: P. H. Dunn in litt. (1966); Rome Rpt. (1975)

Epiblemma scutulana (Denis and Schiffermüller) (= *E. pflugiana* (Haworth))

Plant recs.: *Carduus acanthoides* (France); *C. nutans* (Europe); *Cirsium* (France as *E. pflugiana* and Europe as *E. ?pflugiana*); *Carlina*, *Centaurea* (Europe); other Compositae (in lab. tests)

LEPIDOPTERA—Continued

Olethreutidae—Continued

Remarks: Larvae rare; in stems of *Carduus nutans* and *C. acanthoides* (Europe)

Results of lab. tests (Delémont): Larvae developed successfully to live pupae only on *Cirsium*; fed to various degrees with some larval development (no live pupae) on *Centaurea* (fed heavily), *Aster*, *Echinops*, *Cynara*, *Onopordum*, *Silybum*, *Cnicus*, *Zinnia*, and *Lactuca* (no *Carduus* incl. in these tests)

This sp. was first discovered (first known as *E. pflugiana*) and tested for biological control of *Cirsium* at Delémont in 1961; small shipment of pupae (as *E. scutulana*) sent to Canada in 1962; recorded tachinid parasite: *Actia lamia* (Meigen)

Sources: Delémont Rpts. (1961–63); Zwölfer (1965a)

Eucosma sp. (? = *cana* Haworth)

Plant recs.: *Carduus personatus* (Austria); *Cirsium*, *Centaurea* (Europe)

Remarks: Larvae endophytic in flower heads of these hosts

Sources: Delémont Rpt. (1963); Zwölfer (1965a)

?Grapholitha sp.

Plant recs.: *Carduus acanthoides* (France)

Remarks: Larvae in stems

Sources: Delémont Rpt. (1963)

Herpestes sp. (= "Acroclita sp.")

Plant recs.: *Cuscuta* (Bangladesh, Pakistan); *Carduus*, many other plants (in lab. tests only)

Remarks: Main enemy of *Cuscuta* in Pakistan, attacking fruits and vines; *Carduus edelbergii* and other plants received slight feeding by larvae in lab. tests; larvae completed development on several economic plants; not likely of use in biological control of *Cuscuta*

Sources: A17-ENT-9 Rpts. (1961–65); A17-ENT-14 Rpts. (1967–68); Rawalpindi Rpts. (1967–68); CIBC Ann. Rpt. (1967)

Pterophoridae

Platyptilia carduidactyla (Riley)

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Larvae in stems; attacks other Compositae, including *Cynara*

Sources: Morihara and Balsbaugh (1976)

Tortricidae

Unident. tortricid spp.

Plant recs.: *Carduus acanthoides* (France); *C. nutans* (S. Dak.)

Remarks: Larvae in flower heads

Sources: Delémont Rpt. (1962); Morihara and Balsbaugh (1976)

Unident. cnephasiine sp.

Plant recs.: *Carduus acanthoides* (Europe)

Remarks: Occasional visitor

Sources: Zwölfer (1965a)

Archips sp.

Plant recs.: *Carduus edelbergii* (Pakistan)

Remarks: Larvae exophytic on stems and leaves; polyphagous crop pest

Sources: Baloch et al. (1971)

Clepsis strigana (Hübner)

Plant recs.: *Carduus nutans* (Austria)

Remarks: Larvae on leaves

Sources: Delémont Rpt. (1963)

Cnephasia spp.

Plant recs.: *Carduus acanthoides* (Austria); *C. defloratus* (France); *C. nutans* (Europe)

Remarks: Larvae on *C. acanthoides* and *C. defloratus*; occasional visitor on *C. nutans*

Sources: Delémont Rpt. (1962); Zwölfer (1965a)

Cnephasiella incertana (Treitschke)

Plant recs.: *Carduus nutans*, *Cirsium* (Europe)

Remarks: Listed as occasional visitor on *C. nutans*

Sources: Zwölfer (1965a)

Cochylidae (= Phaloniidae)

Unident. cochylid sp.

Plant recs.: *Carduus nutans* (Europe)

Remarks: Larvae endophytic in flower heads and buds

Sources: Zwölfer (1965a)

Cochylis dubitana (Hübner)

Plant recs.: *Carduus nutans*, *C. acanthoides*, *Arctium* (Europe); *Circium*, *Centaurea*

Remarks: Larvae endophytic in flower heads and buds

Sources: Hannemann (1964); Zwölfer (1965a)

Cochylis sp. nr. *C. posterana* (Zeller) or *C. hybridella* (Hübner)

Plant recs.: *Carduus edelbergii*, *Cnicus* (Pakistan)

LEPIDOPTERA—Continued

Cochylidae—Continued

Remarks: Larvae bore into flowers for feeding; no other hosts known; of possible interest as a biological control agent; efforts to study biology in lab. (Rawalpindi) unsuccessful; more study warranted

Sources: A17-ENT-9 Rpts. (1962–63, 1965); A17-ENT-14 Rpt. (1966); Rawalpindi Rpts. (1966, 1968); Baloch et al. (1971); Baloch and Khan (1973)

Cochylis posterana (Zeller) (= *Phalonia posterana*)

Plant recs.: *Carduus nutans* (Rhine Valley, Europe); *C. acanthoides* (France, Europe); *C. personatus* (Europe); *C. crispus* (Europe); *C. pycnocephalus* (S. Europe, France); *Cirsium* (Austria, France, Switzerland, Europe); *Centaurea* (Austria, Europe); *Arctium*, *Onopordum*, *Serratula*, *Carlina* (Europe)

Remarks: Larvae reared from flowers; endophytic

Sources: Delémont Rpts. (1962–63); Zwölfer (1965a); CIBC Ann. Rpt. (1969); Goeden (1974)

Euxanthoides straminea (Denis and Schiffermüller)

Plant recs.: *Centaurea* (S. Europe); *Carduus nutans*, *Carthamus* (lab. tests)

Remarks: Oviposited on *Carduus nutans* and other Compositae in lab. tests

Sources: Delémont Rpt. (1970); CIBC Ann. Rpt. (1970)

Cosmopterigidae

Pyroderces argyrogrammos Zeller

Plant recs.: *Carduus nutans* (Upper Rhine Valley, Austria); *C. pycnocephalus* (S. Europe); *C. crispus* (Upper Rhine Valley); *Centaurea* (?France, Switzerland, Romania, Egypt); *Silybum*, *Onopordum*, *Carlina* (Europe); *Silybum* (Egypt)

Remarks: Larvae endophytic in flower heads

Sources: Delémont Rpts. (1962–63, 1965–66); CIBC Ann. Rpt. (1965); Zwölfer (1965a); F4-ENT-5 and F4-ENT-16 Rpts. (1966–68, 1976); Goeden (1974)

Gelechiidae

Scrobipalpa acuminatella Sircom (= *Lita acuminatella*)

Plant recs.: *Carduus nutans*, *Cirsium*, *Onopordum*, *Serratula*, *Centaurea* (literature recs., Europe)

Remarks: Larvae mining leaves

Sources: Schutze (1931); Zwölfer (1965a)

Oecophoridae

Agonopteryx arenella (Denis and Schiffermüller)

Plant recs.: *Carduus nutans*, *C. personatus*, *Cirsium* (Europe)

Remarks: Larvae reared externally on stems and leaves; reported mining shoots of *Cirsium* in Switzerland

Sources: Delémont Rpts. (1962–63); Zwölfer (1965a)

Agonopteryx propinquella (Treitschke)

Plant recs.: *Carduus acanthoides* (Switzerland); *Cirsium*, *Onopordum*, *Serratula* (Europe)

Remarks: Larvae mine leaves; ident. of larvae from *C. acanthoides* not verified

Sources: Delémont Rpts. (1962–64); Zwölfer (1965a)

Agonopteryx subpropinquella Stainton

Plant recs.: *Carduus nutans*, *C. pycnocephalus*, *Cirsium*, *Centaurea*, *Cynara*, *Onopordum* (Europe)

Remarks: Locally common; larvae mining leaves

Sources: Schutze (1931); Delémont Rpt. (1964); Zwölfer (1965a); Goeden (1974)

Endrosis sarcitrella (L.) (= *E. lactaeella* Schiffermüller)

Plant recs.: *Carduus acanthoides* (Europe); *Cirsium* (Rhine Valley, France); *Centaurea* (Europe)

Remarks: Larvae feed in flower heads, destroy seeds; listed as occasional visitor on *C. acanthoides*; recorded in literature on mushrooms, fruits, flour, etc.; of no interest in biological control

Sources: Delémont Rpt. (1962); Zwölfer (1965a)

Glyphterygidae

Choreutis bjerkanella Thunberg

Plant recs.: *Carduus crispus*, *Carlina* (Europe)

Remarks: Larvae mining leaves of *C. crispus*; found externally on leaves of *Carlina*

Sources: Schutze (1931); Zwölfer (1965a)

Coleophoridae

?*Coleophora* sp.

Plant recs.: *Carduus defloratus* (Switzerland)

Remarks: Case (only) found on plant

Sources: Delémont Rpt. (1962)

Coleophora ?aeripennis Wocke

Plant recs.: *Carduus defloratus* (Europe)

Remarks: Larvae mine leaves; European literature recs. for *C. aeripennis* = *Arctium*, *Serratula*, and *Centaurea*

Sources: Zwölfer (1965a)

LEPIDOPTERA—Continued

Coleophoridae—Continued

Coleophora therinella TengströmPlant recs.: *Carduus nutans*, *Cirsium*, *Carlina* (Europe)

Remarks: Larvae mining leaves

Sources: Zwölfer (1965a)

DIPTERA

Cecidomyiidae

Unident. cecidomyiid spp.

Plant recs.: *Carduus nutans*, *C. defloratus*, *C. acanthoides*, *C. crispus* (Europe); *C. nutans* (S. Dak.); *C. pycnocephalus* (Egypt)

Remarks: Larvae endophytic in buds, galls, and flower heads

Sources: Ross and Hedicke (1927); Zwölfer (1965a); F4-ENT-5 Rpt. (1970); Morihara and Balsbaugh (1976)

Jaapiella cirsicola RubsaamenPlant recs.: *Carduus crispus*, *Cirsium* (Europe)

Remarks: Larvae endophytic in (and deforming) flower heads

Sources: Buhr (1964); Zwölfer (1965)

Syrphidae

Cheilosia sp.Plant recs.: *Carduus crispus* (Switzerland); *C. acanthoides*, *C. personatus*, *C.* sp. (Austria); *C. nutans* (Italy, France, Europe); *C. tenuiflorus*, *C. pycnocephalus*, *Cirsium* (Italy)Remarks: Generic identity of some of these larval recs. originally questioned; larvae (usually solitary) mine stems, roots, and sometimes buds and crowns, damaging 10 percent of rosettes; rec. from *Carduus* sp. in Austria was as leaf miner; only specimen reared (from many larvae) in Italy was identified as *Cheilosia chrysocoma* (from *C. nutans*)

Sources: Delémont Rpts. (1962–63); Rome Rpts. (1965, 1974–75); Zwölfer (1965a); K. E. Frick in litt. (1966)

Cheilosia chrysocoma (Meigen)Plant recs.: *Carduus nutans* (Italy); *C. crispus* (Europe)

Remarks: Larvae (usually solitary) in stems and crowns; only specimen reared to adult (from many syr-

phid larvae found on *Carduus* spp.) in Italy was identified as *C. chrysocoma* (from *C. nutans*); *C. chrysocoma* chosen for study for possible use in biological control of *Carduus* (Rome)

Sources: Brauer (1883); K. E. Frick in litt. (1966); Rome Rpt. (1975)

Cheilosia cynocephala Loew

Plant recs.: *Carduus nutans* (Europe)

Remarks: None

Sources: Brauer (1883); K. E. Frick in litt. (1966); Rome Rpt. (1975)

Cheilosia flavigornis (F.)

Plant recs.: *Carduus crispus*, ?*Cnicus* (Europe)

Remarks: None

Sources: Brauer (1883); K. E. Frick in litt. (1966)

Cheilosia grossa Fallén

Plant recs.: *Carduus pycnocephalus*, *C. nutans*, *C. crispus*, *Cnicus* (Europe)

Remarks: Adults feed on pollen in early spring

Sources: Mellini (1951a); Goeden (1974); Rome Rpt. (1975); F. C. Thompson in litt. (1976)

Cheilosia mutabilis (Fallén)

Plant recs.: *Carduus acanthoides* (Europe)

Remarks: None

Sources: F. C. Thompson in litt. (1976)

Cheilosia variabilis (Panzer)

Plant recs.: *Carduus nutans* (Italy); *Cirsium*, *Scrophularia* (Europe)

Remarks: Larvae in stems

Sources: Rome Rpt. (1975)

Platystomatidae

Platystoma sp.

Plant recs.: *Carduus nutans* (Europe)

Remarks: Occasional visitor

Sources: Zwölfer (1965a)

Platystoma seminationis F.

Plant recs.: *Carduus crispus* (Europe)

Remarks: Larvae endophytic in flower heads and buds; has been reared from mushrooms

Sources: Zwölfer (1965a)

Tanyderidae

Unident. tanyderid sp.

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Rare

Sources: Morihara and Balsbaugh (1976)

DIPTERA—Continued

Tephritidae (= Trypetidae)

Unident. tephritis spp.

Plant recs.: *Carduus defloratus*, *C. acanthoides* (Switzerland); *C. nutans* (Austria); *C. tenuiflorus* (France); *C. pycnocephalus* (S. Calif.)

Remarks: Larvae found in flower heads in all these recs.; addit. rec. of unident. adult on *C. defloratus*; larvae on *C. acanthoides* in 1 rec. said to be gregarious

Sources: Delémont Rpts. (1962–63); Goeden (1974)

Acanthiophilus eluta (Meigen) (= *A. helianthi* (Rossi))

Plant recs.: *Carduus pycnocephalus* (France, Italy); *C. edelbergii* (Pakistan); *C. personatus* (Austria); *Cirsium* (France, Europe); *Centaurea* (France, Pakistan, Italy, Romania, Bulgaria, USSR (Caucasus), Egypt, Syria, Lebanon); *Carthamus* (India, Pakistan); *Carlina* (Austria); *Cynara*, *Onopordum* (Italy); *Serratula*, *Xeranthemum*, *Leuzea* (Europe); *Cnicus*, *Echinops* (Pakistan); *Silybum* (Egypt, Pakistan, Lebanon)

Remarks: Larvae reared from flower heads, tend to be gregarious; viable seed production reduced; polyphagous within Cynareae; major pest of *Carthamus* in India and Pakistan; most important enemy of *Centaurea* in Europe and Egypt; some oviposition tests conducted on *Centaurea* (at Delémont)

Sources: Rome Rpts. (1959, 1963); L. A. Andres in litt. (1961); A17-ENT-9 Rpts. (1961–62, 1964–65); CIBC Ann. Rpts. (1961, 1965–66); Delémont Rpts. (1963, 1965–68); Zwölfer (1965a); F4-ENT-5 and F4-ENT-16 Rpts. (1966–68, 1976); Baloch et al. (1971); Zwölfer (1974)

Chaetostomella cylindrica (Robineau-Desvoidy) (= *C. onotropes* Loew)

Plant recs.: *Carduus nutans*, *C. crispus* (Europe); *Cirsium*, *Serratula* (Austria, Europe); *Centaurea*, *Microlonchus* (Europe)

Remarks: Larvae reared from flower heads

Sources: Delémont Rpt. (1963); Zwölfer (1965a)

Euaresta bella (Loew)

Plant recs.: *Carduus nutans* (S. Dak.)

- Remarks: Endophagous in flowers; normally in *Ambrosia* seeds
- Sources: Morihara and Balsbaugh (1976)
- Orellia winthemi* Meigen
- Plant recs.: *Carduus crispus* (Britain, Rhine Valley); *C. crassifolius* (Austria); ?*C. acanthoides* (Europe)
- Remarks: Larvae in flower heads; identity of larvae from *Carduus defloratus* and *C. acanthoides* not verified
- Sources: Delémont Rpt. (1963); Zwölfer (1965a, 1974)
- Paracantha culta* (Wiedemann)
- Plant recs.: *Carduus nutans* (S. Dak.)
- Remarks: Endophagous; polyphagous
- Sources: Morihara and Balsbaugh (1976)
- Tephritis* sp.
- Plant recs.: *Carduus edelbergii*, *Cirsium* (Pakistan)
- Remarks: Six generations per year in unopened flower heads; did not attack other Compositae tested in lab.
- Sources: CIBC Ann. Rpt. (1969)
- Tephritis cardualis* Hardy
- Plant recs.: *Carduus edelbergii*, *Cirsium* spp. (Pakistan)
- Remarks: Endophytic in flowers
- Sources: Rawalpindi Rpt. (1968); Baloch et al. (1971)
- Tephritis heiseri* Frauenfeld
- Plant recs.: *Carduus nutans* (Europe); *C. edelbergii* (Pakistan); *C. acanthoides* (Europe, ?Austria); *C. defloratus* (Europe); *Cirsium*, *Cnicus* (Pakistan)
- Remarks: Larvae reared from flower heads; larvae of Austrian rec. from *C. acanthoides* not reared; biological studies conducted at Rawalpindi: Lab. oviposition obtained on *C. nutans* but not on 7 other spp. of Compositae; recorded parasites (Pakistan): *Paraholaspis* sp. and *Tetrastichus* sp.
- Sources: Séguy (1934); A17-ENT-Rpts. (1962-63, 1965); Delémont Rpt. (1963); CIBC Ann. Rpts. (1965-68); Zwölfer (1965a); A17-ENT-14 Rpts. (1966-68); Rawalpindi Rpts. (1966-68); Baloch et al. (1971)
- Tephritis hyoscyami* (L.)
- Plant recs.: *Carduus personatus* (Austria, France); *C. uncinatus* (USSR); *C. nutans* (Europe); *C. crispus*

(Sweden, Britain); ?*C. acanthoides* (Austria); *Carduus* sp. (Sweden)

Remarks: Larvae reared from flower heads; larvae from *C. acanthoides* not reared, may be *Tephritis heiseri*; formed galls in *Carduus* sp.

Sources: Séguay (1934); Delémont Rpt. (1963); Zwölfer (1965a, 1974); A17-ENT-9 Rpt. (1965)

Terellia serratulae (L.)

Plant recs.: *Carduus nutans* (Europe, Britain); *C. defloratus* (Switzerland, Europe); *C. crassifolius* (Austria); *C. acanthoides* (Europe); *C. tenuiflorus* (France); *C. edelbergii* (Pakistan); *Cirsium* (Europe, Pakistan); *Onopordum*, *Galactites*, *Centaurea* (Europe); *Cnicus* (Pakistan)

Remarks: Larvae attack seeds and tissue of flower heads of *Carduus*; found to reduce both seed production and seed viability of *C. edelbergii* (in Pakistan)

Field and lab. studies conducted at Rawalpindi: Regular oviposition and successful larval development obtained only on *Carduus edelbergii* and *Cnicus*; in early test, some oviposition obtained on following plants (in isolation): *Cynara*, *Conyza*, *Centaurea*, *Cousinia*, *Acroclinium*, *Gerbera*, *Gaillardia*, and in later test on *Calendula*; no larval feeding seen on these plants; recorded parasites (Pakistan): *Paraholaspis cothurnata* Masi and *Tetrastichus* sp.

Sources: Séguay (1934); A17-ENT-9 Rpts. (1961-65); CIBC Ann. Rpts. (1961, 1963, 1965-68); Delémont Rpts. (1961-64, 1966); Zwölfer (1965a); A17-ENT-14 Rpts. (1966-67); Rawalpindi Rpts. (1966-68); Baloch et al. (1971); Baloch and Khan (1973); Zwölfer (1974)

Urophora sp. nr. *U. approximata* (Hering)

Plant recs.: *Carduus defloratus* (Switzerland)

Remarks: Larvae endophytic in flower heads and/or buds; true *U. approximata* rec. (Europe) only from *Cirsium*

Sources: Hering (1938); Zwölfer (1965a, 1974)

Urophora cardui (L.)

Plant recs.: *Cirsium arvense* only (Europe); *Carduus nutans* (in lab. tests)

- Remarks:** Larvae endophytic in stems
 In lab. tests: Will oviposit on *Cirsium vulgare* and *Carduus acanthoides* if *Cirsium arvense* is absent; some larval development in *Carduus nutans*
- Galls sent to Canada from Europe for *C. arvense* control: 1,400 (1969), 750 (1973), and 1,080 (1974); U.S. Working Group on Biological Control of Weeds approved release in Canada (1974) and in U.S. (1977); releases (against *C. arvense*): 274 in B.C. and 574 in Sask. (3 sites) in 1974; 96 in Que., 81 in Ont., 98 in B.C., and 374 in Sask. (3 sites) in 1975; 951 in Sask. (5 sites), 472 in Alta. (2 sites), 199 in B.C., 52 in Ont., 451 in Que. (4 sites), and 191 in N.B. (2 sites) in 1976
- Sources:** Delémont Rpts. (1961–67, 1970); Zwölfer (1965a); Peschken (1971); Peschken and Harris (1975); Harris (1975)
- Urophora ?eriolepidis* (Loew)
Plant recs.: *Carduus nutans* (Rhine Valley); *Cirsium*, *Centaurea* (Europe)
- Remarks:** Larvae doubtfully identified as *U. eriolepidis* found in flower heads of *C. nutans* in association with larvae of *Urophora solstitialis*; larvae definitely identified as *U.* (or *Euribia*) *eriolepidis* reared only from *Cirsium* (Germany, Europe)
- Sources:** Ross (1927); Delémont Rpts. (1963–64); Zwölfer (1965a)
- Urophora ?solstitialis* (L.)
Plant recs.: *Carduus nutans* (France, Italy, Rhine Valley); *C. acanthoides* (France); *C. pycnocephalus* (S. Europe); *C. crispus* (Rhine Valley); *C. defloratus* (Switzerland); *C. edelbergii* (Pakistan); *C. personatus* (Europe); ?*Arctium*, ?*Carthamus*, *Carlina*, *Centaurea* (Europe)
- Remarks:** Ident. often questioned; larvae from galls in flower receptacles; feed on seeds
- Sources:** Ross (1927); Séguy (1934); Mellini (1952); H. L. Parker in litt. (1957); Delémont Rpts. (1963–64); Zwölfer (1965a); L. A. Andres in litt. (1966); Rawalpindi Rpt. (1968); CIBC Ann. Rpt. (1971); Baloch et al. (1971); Goeden (1974)

DIPTERA—Continued

Tephritidae—Continued

Urophora stylata (F.)

Plant recs.: *Carduus acanthoides*, *C. personata*, *C. nutans* (Europe); *C. edelbergii*, *Cnicus* (Pakistan); *Cirsium*, *Senecio* (Europe)

Remarks: Larvae endophytic in flower heads and buds; European specimens mostly from *Cirsium*; Pakistan specimens from *Carduus edelbergii*, *Cnicus*, and *Cirsium*

Results of lab. oviposition tests (Delémont, 1966–68): Regular oviposition obtained only on *Cirsium*, occasionally on *Carduus acanthoides*, *Arctium*, *Onopordum*, and on *Centaurea* when artificially stimulated (Rawalpindi, 1966–68). Oviposition obtained only on *Carduus edelbergii* and *Cnicus*

Shipments of 750 galls containing *U. stylata* larvae made in 1964–67 from Delémont to Belleville, Ont., for testing as control agent of *Cirsium vulgare*; U.S. Working Group on Biological Control of Weeds approved release in Canada in 1973

Releases (against *Cirsium vulgare*): 1,227 adults released in B.C. (4 locs.) in 1973, established, and populations increasing by 1975; 123 larvae released in Que. in 1976; Pakistan population possible biological control agent for *Carduus nutans* and/or *Cnicus wallichii*

Sources: Séguay (1934); Delémont Rpts. (1961–68); A17-ENT-9 Rpts. (1963–65); CIBC Ann. Rpts. (1964–67, 1973–74); Zwölfer (1965a, 1974); Baloch et al. (1971); Williamson (1974); Harris (1975)

Xyphosia miliaria (Schrink)

Plant recs.: *Carduus nutans*, *Cirsium* (Europe)

Remarks: Larvae endophytic in flower heads and buds

Sources: Séguay (1934); Delémont Rpts. (1961–65); Zwölfer (1965a, 1974)

Drosophilidae

Scaptomyza pallida (Zetterstedt) (= *Parascaptomyza pallida*)

Plant recs.: *Carduus edelbergii* (Pakistan)

Remarks: Larvae mine leaves; no other host known

Sources: A17-ENT-9 Rpts. (1964-65); Baloch et al. (1971)

Chloropidae

Oscinella spp.

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: Common; endophagous in stems

Sources: Morihara and Balsbaugh (1976)

Polyodaspis sp.

Plant recs.: *Carduus edelbergii*, *Cnicus* (Pakistan)

Remarks: Pupae found in flowers; status unknown

Sources: A17-ENT-9 Rpt. (1965); Baloch et al. (1971)

Agromyzidae

Unident. agromyzid spp.

Plant recs.: *Carduus crispus* (Rhine Valley); *C. pycnocephalus* (Egypt)

Remarks: Adults

Sources: Delémont Rpt. (1962); F4-ENT-5 Rpt. (1969)

Agromyza apfelbecki Strobl

Plant recs.: *Carduus acanthoides* (Hungary); *Cynara* (Europe)

Remarks: Leaf miner; pest of *Cynara*

Sources: Spencer (1973)

Cerodontha dorsalis (Loew)

Plant recs.: *Carduus nutans* (S. Dak.)

Remarks: In leaves; polyphagous

Sources: Morihara and Balsbaugh (1976)

Liriomyza sp. nr. *L. eupatorii* Kaltenbach

Plant recs.: *Carduus pycnocephalus* (S. Calif.)

Remarks: Rare; larvae endophytic in leaves

Sources: Goeden (1974)

Melanagromyza sp. (poss. *M. aeneoventris* (Fallén))

Plant recs.: *Carduus crispus* (Rhine Valley); *C. acanthoides* (Europe); *Cirsium* (Europe)

Remarks: Larvae found in stems of *C. crispus*

Sources: Séguay (1934); Delémont Rpt. (1963); Zwölfer (1965a)

Melanagromyza aeneoventris (Fallén) (= *M. cirsii* (Rondani))

Plant recs.: *Carduus nutans*, *C. acanthoides* (Europe); *C. edelbergii* (Pakistan); *Carduus* sp. (Argentina); *Cirsium*, *Centaurea*, *Senecio*, other Compositae (Europe)

Remarks: Larvae mine within the pith of stems; pupae parasitized by *Tetrastichus* sp.

Sources: Séguay (1934); Delémont Rpt. (1962); A17-ENT-19 (1962, 1965); A7-ENT-9 Rpts. (1964-65); Rome Rpt. (1965); Baloch et al. (1971)

DIPTERA—Continued

Agromyzidae—Continued

Napomyza lateralis (Fallén)

Plant recs.: *Carduus nutans*, *C. pycnocephalus* (Italy);
Centaurea, *Calendula* (Europe)

Remarks: Common feeder on Compositae

Sources: Spencer (1973)

Phytomyza sp.

Plant recs.: *Carduus pycnocephalus* (S. Europe)

Remarks: Occasional larvae; endophagous in leaves

Sources: Goeden (1974)

Phytomyza affinis Fallén

Plant recs.: *Carduus acanthoides* (Finland); *Cirsium*, *Onopordum*, *Serratula* (Europe)

Remarks: Leaves mined

Sources: Séguay (1934); Delémont Rpt. (1962); Zwölfer (1965a)

Phytomyza cardui Hering

Plant recs.: *Carduus crispus*, *Cirsium* (France)

Remarks: Larvae in leaf galls

Sources: Buhr (1964); Zwölfer (1965a)

Phytomyza cirsii Hendel

Plant recs.: *Carduus* (Finland, Britain); *Cirsium*, *Serratula* (Europe)

Remarks: Leaves mined

Sources: Séguay (1934); Parmenter (1952)

Phytomyza farfarella Hendel (= *P. atricornis* Meigen)

Plant recs.: *Carduus personatus* (France); *C. crispus* (Czechoslovakia); *C. pycnocephalus* (U.S., Canada); *Cirsium*, *Onopordum*, *Silybum*, *Xeranthemum* (Europe); *Xanthium*, *Carthamus*, *Salvia*, *Centaurea*, *Cannabis*, *Conyza*, *Datura*, *Silybum*, *Trichodesma* (Pakistan); ?*Centaurea* (Egypt); many other hosts

Remarks: Larvae mine leaves; occasional visitor on these hosts in Europe

Sources: Frick (1959); A17-ENT-9 Rpts. (1961, 1965); Delémont Rpts. (1962–63); Zwölfer (1965a); F4-ENT-5 Rpts. (1966–68); Baloch et al. (1968)

Phytomyza syngenesiae (Hardy) (= *P. "atricornis* Meigen" in part)

Plant recs.: *Carduus crispus* (Sweden); several other Compositae (rarely other plants) (Europe, N. Amer., Australia, New Zealand)

Remarks:	Leaf miner; pest of lettuce and chrysanthemum
Sources:	Spencer (1973)
Anthomyiidae	
Unident. dipterous larvae, prob.	<i>Pegomya terebrans</i> (Rondani) (= <i>P. nigricornis</i> (Strobl))
Plant recs.:	<i>Carduus pycnocephalus</i> , <i>Cynara</i> (Italy)
Remarks:	Larvae mine leaves; larvae from <i>Cynara</i> ident. as <i>P. terebrans</i>
Sources:	Rome Rpt. (1965); Goeden (1974)
<i>Hylemya</i> spp.	
Plant recs.:	<i>Carduus nutans</i> (S. Dak.)
Remarks:	Endophagous
Sources:	Morihara and Balsbaugh (1976)
<i>Pegomya carduorum</i> Huckett (= <i>P. bicolor</i> (Wiedemann))	
Plant recs.:	<i>Carduus pycnocephalus</i> , <i>Cirsium</i> (Calif.)
Remarks:	Common; larvae mine leaves; reared
Sources:	Albany Rpts. (1968-69); Goeden (1974); G. Steyskal in litt. (1977)
<i>Pegomya fodiens</i> (Hendel) (= <i>Carduiphila fodiens</i>)	
Plant recs.:	<i>Carduus crassifolius</i> (Europe)
Remarks:	Mine leaves
Sources:	G. Steyskal in litt. (1977)
<i>Pegomya steini</i> Hendel	
Plant recs.:	<i>Carduus crispus</i> (Britain)
Remarks:	None
Sources:	Niblett (1957)

FUNGI ASSOCIATED WITH CARDUUS THISTLES

The use of plant pathogens for weed control has been reviewed by Wilson (1969) and Hasan (1974). It would be desirable to introduce highly specific fungi to control *Carduus* thistles with no danger to other plants. Smuts and some rust strains are notably species, subspecies, variety, or even race specific. The successful establishment of an Italian strain of *Puccinia chondrillina*Bubak & Sydow to control the Eurasian skeletonweed (*Chondrilla juncea* L.) in Australia was discussed by Hasan (1971).

Carduus thistles are attacked by a variety of relatively nonspecific and specific fungi, according to information extracted from herbarium specimens and the host or fungus index in the National Fungus Collections, Plant Protection Institute, Beltsville

Agricultural Research Center, Beltsville, Md. Recorded nonspecific fungi are as follows:

Ascochyta phomoides Saccardo

Bremia lactucae Regel

B. tulasnei (Hoffman) Sydow

Cercospora carduicola P. Brunaud

Cladosporium herbarum Link ex Fries

Erysiphe cichoracearum DC. ex Mérat

Fusicladium aronici Saccardo

F. schnablianum Allescher

Heteropatella umbilicata (Persoon) Saccardo

Leptosphaeria carduina Passerini

L. clivensis (Berkeley & Broome) Saccardo

L. purpurea Rehm

Leveillula compositarum Golovin forma *cardui* (Jaczewski) Golovin

L. taurica (Léveille) Arnaud

Macrosporium commune Rabenhorst

Oidium spp.

O. conspicua Fautrey & Lambette

Ophiobolus acuminatus (Sowerby) Duby

O. pellitus (Fuckel) Saccardo

Ovularia vossiana Thümen

Passalora schnabliana (Allescher) Petrak

Phoma albicans Roberge & Desmazieres

P. pycnocephali Passerini

Phragmidium personatae Allescher

Phyllosticta personatae Allescher

Pleospora albicans Roberge & Desmazieres

P. penicillus (Schumacher) Fuckel

Pseudohelotium micaceum (Persoon) Saccardo

Ramularia cardui Karsten

Rhabdospora cirsii Karsten

Sclerotinia sclerotiorum (Libert) DeBary

Scolecotrichum cardui Schroeter

Septoria associata Bubak & Kabat

S. cardui Fossi

Venturia pellita Hazslinszky

In addition, *Carduus glaucus* on limestone is associated with a mycorrhizal fungus in Poland, according to records in the files of the National Fungus Collections. The obligate parasitic fungus *Albugo trogapogi* (Persoon) Schroeter is associated with and may be host specific on *Carduus crispus* in Denmark and the Netherlands.

Carduus micropteris broteri was attacked by the lettuce mosaic virus in Portugal, and a phloem necrosis virus infected *C. nutans* at Beltsville, Md.

The rusts and smuts in the following list are specific to *Carduus* thistles or contain specific races or biotypes attacking various species or varieties of *Carduus*. Because many rusts are highly specific to certain varieties or races of the host, these fungi seem most promising as potential biological control agents, particularly since they have not yet been reported from North America.

LIST OF SPECIFIC FUNGI

UREDINALES

Puccinia cardui-pycnocephali H. Sydow & P. Sydow

Plant recs.: *Carduus pycnocephalus* (Italy, Spain, Yugoslavia, Portugal, Britain, Turkey, Asia Minor, Iran, Cyprus, New Zealand, Azerbaijan SSR, Turkmen SSR, North Africa, Scotland, Palestine); *C. tenuiflorus* (Spain, Portugal, New Zealand, France, Morocco); *C. ammophilus* (as *C. reuterianus*) (Spain); *C. seminudus* (Caucasus – USSR); *C. spachianus* var. *duriaei* Boiss. & Reut. (Morocco); *C. clavulatus* (Canary Is.); *C. ballii*, *C. myriacanthus* (Morocco)

Remarks: States II (uredia) and III (telia) on living leaves and stems; plants persisted but disease disappeared after several years (Switzerland); occurs in June (Portugal)

Sources: Sydow and Sydow (1904); Natl. Fungus Coll.

Puccinia carduorum Jacky (= *P. hieracii* (Roehling) Martius; = *Aecidium cardui* Sowerby; = *Uredo flosculosorum* Albertini & Schweinitz; = *P. flosculosorum* Winter; = *P. cardui-carlinoides* Petrak; = *P. compositarum* Schlechtendahl (in part))

Plant recs.: *Carduus nutans* (France, USSR, Spain, Britain, Germany, Hungary, Lithuanian SSR, Pakistan, Kirghiz SSR, Switzerland, India, Romania); *C. crispus* (France, Switzerland, Romania, USSR, Spain, Siberia, Japan, Korea, Lithuanian SSR (as *Uredo flosculosorum*), Uruguay, Hungary, Finland (Lapland), Norway, Sweden, Germany, Altai Mts. – USSR, Czechoslovakia, Scotland, Europe (as *Puccinia hieracii*, *Uredo hieracii*)); *C. cornius* (Greece (as *C. armatus*), Bulgaria); *C. kerneri* (Europe); *C. defloratus* (Switzerland, France, Austria (as *Aecidium cardui*), Europe (as *Puccinia*

flosculosorum); *C. getulus* (N. Africa); *C. crassifolius* (as *C. glaucus*) (Czechoslovakia); *C. hamulosus* (Hungary); *C. leptocladus*, *C. myriacanthus*, *C. macrocephalus*, *C. meonanthus* (Morocco); *C. candicans* (Europe); *C. personatus* (France, Hungary, Germany, Bulgaria, Switzerland); *C. ammophilus* (as *C. reuterianus*) (Spain, Balearic Is.); *C. tenuiflorus* (Portugal, Spain, France); *C. onopordioides* (Bulgaria); *C. ballii* (Morocco); *C. acanthoides* (Europe (as *Puccinia flosculosorum*), France, Germany, Czechoslovakia, Ukrainian SSR); *C. pycnocephalus* (Turkmen SSR (as *P. hieracii*), Europe, Cyprus, Spain, Iran, Turkey, Turkmen SSR, Uzbek SSR); *C. gayanus* (Spain (as *C. carpetanus*)); *C. thoermeri* (Africa (as *C. leiophyllus*)); *C. chrysacanthus* (France (as *Puccinia carduicarinoides*)); *C. collinus* (Romania, Hungary); *C. kernerii* (as *C. scardicus*) (Bulgaria); *C. (Alfredia) acantholepis* and *C. (A.) nivea* (Kirghiz SSR); *C. (A.) cernua* (Kirghiz SSR, Siberia); *C. chevallieri* (N. Africa); (?) *Silybum marianum* (L.) Gaertn. (Portugal)

Remarks: States II and III on leaves and branches in July and Aug. (Europe, *C. nutans*); II and III common on stems and leaves in July-Oct. (Europe, *C. crispus*, *C. personatus*); June-Oct. (Switzerland, *C. defloratus*)

Sources: Sydow and Sydow (1904); Savulescu (1955); Natl. Fungus Coll.

Puccinia centaureae DC. (= *P. centaureae* Fuckel; = *P. calcitrapae* DC.; = *P. scabiosae* P. Magnus; = *P. jaceae* Otth; = *P. inquinans* Wallroth; = *Epitea jaceae* Otth; = *Uredo flosculosorum* var. *centaureae* Wettstein)

Plant recs.: *Carduus crispus* (Norway, Finland); *C. clavulatus* (Canary Is.); *C. pycnocephalus* (Iraq, Canary Is., as *Puccinia centaureae* forma *asperae* Cast. on *C. pycnocephalus* as *C. tenuifolius*); also literature records from *Centaurea* spp.

Remarks: States II and III on *C. clavulatus* (Canary Is.)

Sources: Sydow and Sydow (1904); Natl. Fungus Coll.

Puccinia cnici-oleracei Persoon ex Desmazieres (= *P. cardui* Plowright; = *P. spectabilis* Otth)

Plant recs.:	<i>Carduus (Afrocarduus) kikuyorum</i> (Kenya); <i>C. (Afrocarduus)</i> sp. (Uganda); ? <i>C. crispus</i> (Germany); <i>Cirsium</i> spp. (Europe); <i>Carthamus</i> (France); <i>Lupsia</i> (Canary Is.); <i>Artemisia</i> (China)
Remarks:	In living leaves; probably several spp.
Sources:	Sydow and Sydow (1904); Natl. Fungus Coll.
<i>Puccinia galatica</i> Sydow	
Plant recs.:	<i>Carduus pycnocephalus</i> var. <i>albidus</i> (Asia Minor); <i>C. arabicus marmoratus</i> (Europe); <i>C. nutans</i> (Sinkiang, China)
Remarks:	On living leaves
Sources:	Sydow and Sydow (1904); Natl. Fungus Coll.

USTILAGINALES

Ustilago cardui F. de Waldheim (= *U. reessiana* Kühn)

Plant recs.:	<i>Carduus acanthoides</i> (as <i>U. reessiana</i>), <i>C. acanthoides</i> , <i>C. nutans</i> (N. Europe); <i>C. defloratus</i> (Switzerland); <i>C. personata</i> (USSR, Europe); <i>C. crispus</i> (USSR – Altai Mts.); <i>C. thoermeri</i> (Europe)
Remarks:	In flower heads; destroys capitulum
Sources:	Savulescu (1955); Natl. Fungus Coll.
<i>Ustilago violacea</i> S. F. Gray (= <i>U. violacea</i> Persoon)	
Plant recs.:	<i>Carduus acanthoides</i> (Germany)
Remarks:	None
Sources:	Natl. Fungus Coll.

SUMMARY

Six Eurasian species of *Carduus* thistles have become established in North America, where they are troublesome weeds in pastures and rights-of-way. A search for biological control agents in Eurasia and North America has shown that *Carduus* spp. are attacked by about 340 species of phytophagous insects, including 71 that are oligophagous on Cynareae. The host range of 39 Eurasian species was determined by laboratory testing (30 Coleoptera, 5 Lepidoptera, and 4 Diptera). Five of them were sufficiently damaging and host specific to warrant their release in North America. The results are as follows:

(1) *Altica carduorum* Guérin-Méneville, repeatedly released against Canada thistle (*Cirsium arvense* (L.) Scop.) but not yet established in North America.

(2) *Ceutorhynchus litura* (F.), first released against *Cirsium arvense* and established in Sask., Ont., Idaho, Mont., and Calif., with some control of the host.

(3) *Rhinocyllus conicus* (Froelich), first released in 1968, established on *Carduus* in Calif., Va., W. Va., Colo., Mo., Mont., Pa., Md., Okla., Ont., Sask., Man., Que., and on *Silybum marianum* (L.) Gaertn. in Calif., with significant localized control of *Carduus* in Va., Mo., and Mont. and of *Silybum* in Calif.

(4) *Trichosirocalus horridus* (Panzer), first released against *Carduus* in 1975 in Canada and Va., establishment in Va. (1978); releases planned in Kans., Mont., Nebr., N. Dak., S. Dak., and Mo. for 1978-79.

(5) *Urophora stylata* (F.), first released against *Cirsium vulgare* (Savi) Ten. in 1973 and established in B.C.

In addition, *Cassida rubiginosa* Mueller, which had been laboratory tested, was found to have been adventively established on *Carduus* and *Cirsium* in northeastern North America since 1927.

Carduus thistles are also attacked by 42 species of fungi; of these, 7 species of *Puccinia* and *Ustilago* may be host specific and are worthy of further investigation.

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